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Colorado State Univ.
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Prepared for

Robert S. Kerr Environmental Research Lab.
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Selected Irrigation Return Flow Quality Abstracts 1978

Eighth Annual Issue

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Research related to the quality of irrigation return flow is being conducted at numerous institutions throughout the western United States. Related work is also underway at other institutions in the United States as well as other portions of the world. Approximately 100 sources of material have been searched for articles pertinent to the Irrigated Crop Production research and development program. These articles describe water quality problems resulting from irrigated agriculture, potential technological solutions for controlling return flows, recent research pertinent to return flow investigations, and literature associated with institutional constraints in irrigation return flow quality control.

The first annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS covered publications printed in 1968 and 1969, while the second annual issue lists publications printed in 1970 and 1971, the third annual issue covers calendar years 1972 and 1973, and the fourth, fifth, sixth and seventh annual issues cover literature published in 1974, 1975, 1976 and 1977. This annual issue lists publications printed in 1978.

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SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS 1978

Eighth Annual Issue

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FOREWORD

The Environmental Protection Agency was established to coordinate administration of the major Federal programs designed to protect the quality of our environment.

An important part of the Agency's effort involves the search for information about environmental problems, management techniques and new technologies through which optimum use of the Nation's land and water resources can be assured and the threat pollution poses to the welfare of the American people can be minimized.

EPA's Office of Research and Development conducts this search through a nationwide network of reserach facilities. As one of these facilities, the Robert S. Kerr Environmental Research Laboratory is responsible for the management of programs to: (a) investigate the nature, transport, fate and management of pollutants in groundwater; (b) develop and demonstrate methods for treating wastewaters with soil and other natural systems; (c) develop and demonstrate pollution control technologies for irrigation return flows; (d) develop and demonstrate pollution control technologies for animal production wastes; (e) develop and demonstrate technologies to prevent, control or abate pollution from the petroleum refining and petrochemical industries; and (f) develop and demonstrate technologies to manage pollution resulting from combinations of industrial wastewaters or industrial/municipal wastewaters.

This report provides a single source abstracted and indexed reference of research on water quality problems of irrigation return flows and the potential technological solutions and institutional constraints to solutions of those problems. The sources abstracted include coverage of work in the United States and other parts of the world. Current knowledge of related research is essential if optimum use is to be made of our available resources in developing reasonable, cost effective, environmentally sound solutions to the problems encountered in the control of water quality in return flows from irrigated agriculture.

William C Galegar

William C. Galegar
Director, Robert S. Kerr Environmental Research Laboratory

PREFACE

The eighth annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS has been compiled from approximately 100 sources of material covering calendar year 1978. This compilation has attempted to include technological and institutional articles that would be pertinent to action programs regarding the control of water quality degradation resulting from irrigated agriculture.

The state-of-the-art report, "Characteristics and Pollution Problems of Irrigation Return Flow," prepared by the Utah State University Foundation, contains a bibliography of articles pertinent to Irrigation Return Flow Quality through 1967. The first annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS listed publications appearing in calendar years 1968 and 1969, while the second annual issue listed publications appearing in calendar years of 1970 and 1971, the third annual issue contained abstracts of articles and reports published during calendar years 1972 and 1973, and the fourth, fifth, sixth and seventh annual issues contained abstracts of 1974, 1975, 1976 and 1977 publications. The eighth annual issue contains 787 abstracts of documents published during calendar year 1978. The abstracts have been placed into sections according to the category and subgroup classifications used by the Water Resources Scientific Information Center (WRSIC) as published in the report, "Water Resources Thesaurus." The abstracts have been forwarded to WRSIC for inclusion in their bi-monthly publication, "Selected Water Resources Abstracts."

ABSTRACT

Research related to the quality of irrigation return flow is being conducted at numerous institutions throughout the western United States. Related work is also underway at other institutions in the United States, as well as other portions of the world. Approximately 100 sources of material have been searched for articles pertinent to the Irrigated Crop Production research and development program. These articles describe water quality problems resulting from irrigated agriculture, potential technological solutions for controlling return flows, recent research pertinent to return flow investigations, and literature associated with institutional constraints in irrigation return flow quality control.

The first annual issue of SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS covered publications printed in 1968 and 1969, while the second annual issue lists publications printed in 1970 and 1971, the third annual issue covers calendar years 1972 and 1973, and the fourth, fifth, sixth and seventh annual issues cover literature published in 1974, 1975, 1976 and 1977. This annual issue lists publications printed in 1978. This report was submitted in fulfillment of Grant No. R-800426 under the sponsorship of the Office of Research and Development, U.S. Environmental Protection Agency.

Key Words: Fertilizers, Irrigated land, Irrigation systems, Irrigation water, Nitrates, Phosphates, Return flow, Salinity, Water pollution effects, Water pollution sources, Water quality control.

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The excellent cooperation of the reading room staff at the Engineering Research Center and the library staff at Colorado State University has been very important in accomplishing the work reported herein.

The scope of this literature abstracting effort has been delineated jointly by the senior author and project officer, Mr. Alvin L. Wood, Source Management Branch, Robert S. Kerr Environmental Research Laboratory, Environmental Protection Agency, Ada, Oklahoma. The cooperative efforts of the Project Officer in meeting with project personnel and reviewing the abstracting process have been very helpful and are sincerely appreciated.

SECTION I

WATER CYCLE

GENERAL (GROUP 02A)

78:02A-001
A METHODOLOGY FOR TESTING THE ACCURACY OF YIELD PREDICTIONS FROM WEATHER-YIELD REGRESSION MODELS FOR CORN,
Nelson, W.L., and Dale, R.F.
Purdue University, West Lafayette, Indiana, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 5, p 734-740, September-October, 1978. 5 tab, 21 ref, 2 equ.

Descriptors: Statistical models, Technology, Weather data, Regression analysis, Corn (field), Nitrogen, Indiana, Crop production.

Analysis of variance (ANOVA) techniques were used to evaluate the accuracy of yield predictions for corn in Indiana counties with four statistical models: 1) Thompson approach, 2) modified Thompson approach with a nitrogen technology term, 3) a 1974 model by Leeper, Runge, and Walker and 4) a 1975 model by Dale and Hodges. For models 1), 2), and 4), separate versions were developed with the particular series of weather and corn yield data for each county. All models were used to predict yearly average corn yields for a county with data not used to fit the regression coefficients. A significant difference among models was detected by the ANOVA. Multiple comparison tests indicated that regression models 2), 3), and 4) were more accurate than model 1). This result was attributed mainly to the handling of technology or the weather-technology interaction effects on corn yields. The trend variables used in model 1) acted to confound weather and technology effects and create unstable regression models. Although the direct application of the results of this study is limited to Indiana, the methodology for testing the accuracy of yield predictions is believed to have universal application.

78:02A-002
CALIBRATION OF HYDROLOGICAL MODEL USING OPTIMIZATION TECHNIQUE,
Manley, R.E.
Severn-Trent Water Authority, Birmingham, England.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol. 104, No. HY2, p 189-202, February, 1978. 4 fig, 3 tab, 20 ref.

Descriptors: *Optimization, *Simulation analysis, *Computer models, *Mathematical models, Digital computers, Droughts, Algorithms, Wave velocity, Model studies, Water resources.

Computer-based mathematical models that simulate the response of a catchment to climatic variables have been available for more than a decade. One of the drawbacks to the use of these models has been the difficulty of calibrating them to a particular catchment. The catchment model HYSIM has all but four of its parameters estimated from catchment details or hydrograph analysis; the four are calibrated using a modified version of the Rosenbrock algorithm. The complete model occupies about 12K words (36K bytes) of computer core storage. HYSIM was used to produce a 44-year record for a river in England extensively used for water supply. Despite the fact that only a limited amount of data was available, the extended record has proven adequate for water resources analysis.

78:02A-003
SENSITIVITY OF GROUNDWATER MODELS WITH RESPECT TO VARIATIONS IN TRANSMISSIVITY AND STORAGE,
McElwee, C.D., and Yukler, M.A.
Geological Survey, Lawrence, Kansas.
Water Resources Research, Vol. 14, No. 3, p 451-459, June, 1978. 14 fig, 15 ref.

Descriptors: *Aquifers, *Groundwater, *Groundwater movement, *Model studies, Transmissivity, Storage coefficient, Drawdown, Hydraulic conductivity, Analytical techniques, Sensitivity analysis, Sensitivity coefficient.

Sensitivity analysis is the study of a system's response to various disturbances. In this study, disturbances of aquifer parameters were considered. In the simulation of an aquifer, the investigator must establish tolerance within which the parameters of the physical system may vary without appreciably affecting the model results. By means of a first-order sensitivity formalism, it was shown how to evaluate the perturbed hydraulic head for a small change in aquifer parameter. An expression for the sensitivity coefficient was obtained in this study by taking the partial derivative of the flow equation with respect to a particular parameter. The sensitivity coefficient was evaluated either analytically or by numerical techniques for some common models. The sensitivity formalism was applied to the Theis equation to study the general behavior of sensitivity coefficients and to determine the range of validity of the first-order sensitivity formalism. The formalism also was applied to one- and two-dimensional numerical models to see the effect of barrier and constant head boundaries. The perturbed hydraulic head was obtained for a change of transmissivity (T) and storage coefficient (S) by applying the first-order sensitivity formalism. This procedure should be a valuable tool in calibrating models or establishing tolerances on T and S for a given acceptable error in hydraulic head. In general, a + or - 20% deviation in T or S may be handled adequately by the first-order formalism discussed in this work.

78:02A-004
MODELING NITROGEN MOVEMENT IN AGRICULTURAL WATERSHEDS,
Campbell, K.L., and Sinai, G.
Florida University, Gainesville, Department of Agricultural Engineering.
Paper No. 78-2071, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 15 p. 1 fig, 22 ref.

Descriptors: Nitrogen, Water quality, Water quality control, Model studies, Simulation analysis, Pollutants, Pollution abatement, Agricultural watersheds, Hydrology, Nutrient removal.

Techniques were developed to simulate nitrogen movement through agricultural watersheds. The USDAHL-74 (USDA-ARS Tech. Bul. No. 1518) model of watershed hydrology was used to provide the hydrologic information required to model nitrogen movement. The ACTMO (agricultural chemical transport model USDA, ARS-H-3) nitrate model was used as a framework for the nitrogen model. Important components to be added to the ACTMO model are discussed.

78:02A-005
A QUASI-LINEAR SPATIALLY DISTRIBUTED CELL MODEL FOR THE SURFACE RUNOFF SYSTEM,
Diskin, M.H., and Simpson, E.S.
Technion-Israel Institute of Technology, Haifa, Israel, Faculty of Civil Engineering.
Water Resources Bulletin, Vol. 14, No. 4, p 903-918, August, 1978. 7 fig, 3 tab, 10 ref.

Descriptors: *Surface runoff, *Watersheds (basins), *Model studies, Precipitation (atmospheric), Precipitation excess, Excessive precipitation, Hydrographs, Analytical techniques, Synthetic hydrology, Hydrology.

The paper presented a spatially distributed model consisting of cells that are interconnected in a pattern similar to the major drainage network of the watershed. Each cell receives as input the rainfall excess for the area represented by the cell as well as inflows from cells located upstream. Outflow from the cell is derived by routing the total input through the cell assuming it to be a linear reservoir during the storm. The time constant of the cell, however, was allowed to vary from storm so that the model may be described as a quasi-linear model. The model was tested with rainfall excess and direct surface runoff data available for a medium size watershed with satisfactory results. The time constant was found to be related to the rainfall excess of the storms studied, its value decreasing with the increase in the total rainfall excess.

78:02A-006
AN ADAPTIVE ALGORITHM FOR ANALYZING SHORT-TERM STRUCTURAL AND PARAMETER CHANGES IN HYDROLOGIC PREDICTION MODELS,
Wood, E.F., and Szollosi-Nagy, A.
Princeton University, New Jersey, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 4, p 577-581, August, 1978. 7 fig, 34 ref, 1 append.

Descriptors: *Rainfall-runoff relationships, *Simulation analysis, *Forecasting, *Input-output analysis, *Algorithms, *State space formulation, Environmental effects, Kalman filters, Ombone River Basin (Italy), Noise covariances.

An adaptive unbiased recursive prediction algorithm, based on the state space description of hydrologic systems, is discussed. Discrete linear systems with white Gaussian disturbances are considered. The algorithm allows for short-term structural and parameter changes due to random environmental effects. A prediction model is set up from a representation of the rainfall-runoff processes with the unknown parameters modeled by a random walk. The predictions are obtained by the use of linear Kalman filters where the unknown noise covariance matrices are also adaptively estimated. The behavior of the adaptive prediction algorithm is illustrated by a real-world example taken from rainfall-runoff flood forecasting.

78:02A-007
CLIMATE, SOIL, AND VEGETATION 7. A DERIVED DISTRIBUTION OF ANNUAL WATER YIELD,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 765-776, October, 1978. 10 fig, 3 tab, 13 ref, 35 equ.

Descriptors: Water yield, Water balance, Soil-water-plant relationships, Soil moisture movement, Precipitation, Storm runoff, Infiltration, Climatic data, Mathematical models, Stochastic processes.

The average annual soil moisture balance, as derived from the mechanics of storm and interstorm soil moisture movement and from the statistics of the climatic variables, were used to define the average annual soil moisture. This soil moisture was used in the equation for average annual yield to give a first-order approximation of the annual precipitation yield function. This function was used to transform the cumulative distribution function (cdf) of annual precipitation into the cdf of annual yield, and application was made in a sub-humid and in an arid climate. The derived yield frequency function is seen to be sensitive to the soil and vegetal properties. Proper selection of these parameters brought close agreement with observed streamflow-frequency and suggested the model's utility for parameterizing drainage basins with respect to effective average soil and vegetal properties.

78:02A-008
CLIMATE, SOIL, AND VEGETATION 6. DYNAMICS OF THE ANNUAL WATER BALANCE,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 749-764, October, 1978. 11 fig, 4 tab, 20 ref, 74 equ.

Descriptors: Water balance, Soil-water-plant relationships, Precipitation (atmospheric), Evapotranspiration, Surface runoff, Groundwater, Climatic data, Moisture deficit, Mathematical models.

Mass conservation was employed to express the natural water balance of climate-soil-vegetation systems in terms of the average annual values of precipitation, evapotranspiration, surface runoff, and groundwater runoff as derived from the probability distributions of storm properties and from the physics of the appropriate storm and interstorm soil moisture fluxes. The resulting conservation equation was used to define the dimensionless parameters governing the dynamic similarity of the annual water balance. An asymptotic analysis of this water balance equation yielded a set of rational criteria for the classification of climate-soil-vegetation systems. Sensitivity with respect to the primary climate, soil, and vegetal parameters demonstrated that qualitative changes in water balance behavior are primarily dependent upon the exfiltration effectiveness of the soil. A natural selection hypothesis was presented which specified the stable vegetation density and the plant coefficient for a given climate-soil system in which water and not nutrition or light was limiting.

78:02A-009
CLIMATE, SOIL, AND VEGETATION 5. A DERIVED DISTRIBUTION OF STORM SURFACE RUNOFF,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 741-748, October, 1978. 6 fig, 2 tab, 11 ref, 76 equ.

Descriptors: Storm runoff, Climatic data, Soil properties, Vegetation, Rainfall-runoff relationships, Soil moisture, Rainfall intensity, Infiltration, Flood discharge, Mathematical models.

The Philip infiltration equation was integrated over the duration of a rainstorm of uniform intensity to give the depth of point surface runoff from such an event on a natural surface in terms of random variables defining the initial soil moisture, the rainfall intensity, and the storm duration. In a zeroth-order approximation the initial soil moisture was fixed at its climatic space and time average, whereupon by using exponential probability density functions for storm intensity and duration, the probability density function of point storm rainfall excess was derived. This distribution was used to define the annual average depth of point surface runoff and to derive the flood volume frequency relation, both in terms of a set of physically meaningful climate-soil parameters.

78:02A-010
HYDROLOGIC MODELING OF SMALL WATERSHEDS IN ASAE MONOGRAPH,
Haan, C.T.
Oklahoma State University, Stillwater, Department of Agricultural Engineering.
Paper No. 78-2588, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 5 p.

Descriptors: Hydrologic cycle, Small watersheds, Model studies, Hydrology, Stochastic processes, Hydrologic properties, Groundwater, Soil water movement, Evapotranspiration, Soil erosion.

This monograph has 13 chapters devoted to modeling of the hydrologic cycle on small watersheds. Primary emphasis is on basic approaches to modeling the various parts of the hydrologic cycle, on combining component models into hydrologic models and on selecting and testing hydrologic models.

78:02A-011
SIMULATED STREAMFLOW RESPONSE TO POSSIBLE DIFFERENCES IN TRANSPIRATION AMONG SPECIES OF HARDWOOD TREES,
Federer, C.A., and Lash, D.
Northeastern Forest Experiment Station, United States Department of Agriculture, Forest Service, Durham, New Hampshire 03824.
Water Resources Research, Vol. 14, No. 6, p 1089-1097, December, 1978. 8 fig, 4 tab, 17 ref.

Descriptors: Streamflow, Transpiration, Hydrologic cycle, Model studies, Simulation analysis, Hardwood, Forest watersheds, Watershed management, Equation, Evapotranspiration, Hydrologic.

Possible differences in transpiration among species of hardwood trees were simulated in a hydrologic model, called Brook, to estimate the effects of these differences on monthly and annual streamflow. Brook is a deterministic, lumped-parameter model that simulated streamflow from small, forested watersheds in the eastern United States. The model uses only daily mean temperature and daily precipitation as input. A 4-week difference in timing of leaf-development in spring or color change in autumn caused differences of 10-60 mm in simulated annual streamflow. When daily transpiration varied by 20%, as it might with differences in leaf diffusive resistance among species, differences in simulated streamflow ranged from 15 to 120 mm annually. Differences in root distribution with depth can affect the availability of soil water; varying this availability caused differences in simulated streamflow of 15-60 mm. In all cases the smaller differences occurred when the soil was dry at the times of differing transpiration. On a deep residual soil the differences in streamflow were spread through the year, but on a shallow till soil the differences were restricted to the months in which there were changes in transpiration. Differences in response among 15 degrees north-facing and 15 degrees south-facing slopes and a horizontal surface were minor.

SECTION II

WATER CYCLE

PRECIPITATION (GROUP 02B)

78:02B-001
CLIMATE, SOIL, AND VEGETATION 2. THE DISTRIBUTION OF ANNUAL PRECIPITATION DERIVED FROM OBSERVED STORM SEQUENCES,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 713-721, October, 1978. 12 fig, 1 tab, 11 ref, 54 equ.

Descriptors: Precipitation (atmospheric), Distribution, Storms, Rainfall, Statistical methods, Probability, Stochastic processes.

Point precipitation was represented by Poisson arrivals of rectangular intensity pulses that have random depth and duration. By assuming the storm depths to be independent and identically gamma distributed, the cumulative distribution function for normalized annual precipitation was derived in terms of two parameters of the storm sequence, the mean number of storms per year and the order of the gamma distribution. In comparison with long-term observations in a subhumid and an arid climate it was demonstrated that when working with only 5 years of storm observations this method tends to improve the estimate of the variance of the distribution of the normalized annual values over that obtained by conventional hydrologic methods which utilize only the observed annual totals.

SECTION III

WATER CYCLE

SNOW, ICE, AND FROST (GROUP 02C)

78:02C-001
WATER REDISTRIBUTION IN PARTIALLY FROZEN, SATURATED SILT UNDER SEVERAL TEMPERATURE GRADIENTS AND OVERBURDEN LOADS,
Loch, J.P.G., and Kay, B.D.
Guelph University, Ontario, Department of Land Resources Science.
Soil Science Society of America Journal, Vol. 42, No. 3, p 400-406, May-June, 1978. 7 fig, 2 tab, 17 ref.

Descriptors: *New Hampshire, *Freezing, *Soil water, *Crystal growth, *Frost heaving, *Cryogenics, Thermocline, Saturated flow, Model studies, Gamma scanning system.

The flux of water and the resultant formation of discrete ice lenses were studied in samples of New Hampshire silt which were saturated and then frozen under different temperature gradients and overburden pressures. A dual energy gamma scanning system was employed to locate the position of the growing ice lens relative to the freezing front. Parameters controlling water flow and the location of the ice lenses were employed to evaluate theories that have been proposed to describe the mechanisms of ice lens formation. The capillary theory was employed to locate the freezing front. However, the ice lenses were found to be located 0.2-0.4 cm behind the freezing front, which is inconsistent with the location of the ice lenses predicted by the capillary theory. Neither the hydrodynamic theory nor the secondary frost heaving theory account for the redistribution of overburden pressure between soil particles, ice, and water. These theories cannot be employed to predict the location of the ice lens relative to the freezing front until overburden pressure effects are incorporated into the theory.

SECTION IV

WATER CYCLE

EVAPORATION AND TRANSPIRATION (GROUP 02D)

78:02D-001
THE DISHONEST METHOD IN STREAM TEMPERATURE MODELING,
Morse, W.L.
Bonneville Power Administration, Portland, Oregon.
Water Resources Research, Vol. 14, No. 1, p 45-51, February, 1978. 1 tab, 18 ref.

Descriptors: *Water temperature, *Streams, *Model studies, *Mathematical models, Stochastic processes, Mathematics, Statistics, Solar radiation, Hydrology, Heat transfer.

The unidimensional form of the thermal energy conservation principle as a quasi-linear partial differential equation (PDE) has been shown accurate for point temperature forecasts on completely mixed streams and river-run reservoir systems. Two methods of solution were presented which lead to a unique solution. Yet this nonrandom solution was contrary to the behavior of nature, and so a philosophic change was introduced. From the PDE subsidiary differential system a stochastic differential equation (SDE) was obtained with random forcing function from the meteorologic and forebay-depth analyses. With random intial conditions (time-averaged components of the in situ water temperature vector), the SDE was recasted as a random nonlinear Volterra integral equation (RIE). Then a solution to the random-initial-conditions RIE (fixed points of the expectations) by the so-called dishonest method was compared with a solution obtained by repetitively solving the PDE as a random equation (expectations of the fixed points). Of course, these solutions, obtained by "dishonest and honest" methods, are not necessarily unique, but they may be sufficiently close in some sense. Hence, proper interpretation and use of this RIE model would enable water resource planners to determine economically stream temperatures in probability during critical climatic or river flow conditions. And then intelligent planning and scheduling could avoid some catastrophic aquatic event which might occur as a result of extreme water temperatures.

78:02D-002
EVALUATION OF EVAPORATION FROM LAKE ONTARIO DURING IFYGL BY A MODIFIED MASS TRANSFER EQUATION,
Phillips, D.W.
Atmospheric Environment Service, Downsview, Ontario, Hydrometeorology and Marine Applications Division.
Water Resources Research, Vol. 14, No. 2, p 197-205, April, 1978. 4 fig, 4 tab, 28 ref.

Descriptors: *Evaporation, *Lake Ontario, *Great Lakes, *International field year, *Lake Hefner, Turbulent energy flux, Multi-regression equations, Hydrologic budget, Stability, Meteorology.

Daily evaporation from Lake Ontario during the International Field Year for the Great Lakes (April, 1972 to March, 1973) was computed by a modified/mass transfer technique. Turbulent energy flux was calculated by using upwind land station data and the surface water temperature at 88 grid points on the lake. Wind speed and humidity at each grid point were determined through multi-regression equations that took into account stability, fetch, and water temperature. Daily, monthly, and annual evaporation amounts obtained by this study were compared to amounts obtained by conventional mass transfer, energy balance, and terrestrial water budget methods, discrepancies in the results of the various approaches were examined and discussed.

78:02D-003
ESTIMATING EVAPOTRANSPIRATION RATES FOR CORN IN DELAWARE,
Ritter, W.F., Williams, T.H., and Eastburn, R.P.
Delaware University, Newark, Department of Agricultural Engineering.
Paper No. 78-2029, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 27 p. 17 fig, 1 tab, 11 ref.

Descriptors: Evapotranspiration, Estimating, Humid climates, Corn (field), Meteorological data, Growth stages, Consumptive use, Delaware.

The Jensen-Haise, Penman, pan evaporation and Thornthwaite methods were used to predict evapotranspiration. All methods underestimated the measured peak ET rates. The critical moisture period for corn was found to be from the 14th leaf stage to beginning dent.

78:02D-004
EVAPOTRANSPIRATION FROM WATER HYACINTH IN TEXAS RESERVOIRS,
Benton, A.R., Jr., James, W.P., and Rouse, J.W.
Texas A & M University, College Station, Department of Civil Engineering.
Water Resources Bulletin, Vol. 14, No. 4, p 919-930, August, 1978. 3 fig, 3 tab, 21 ref.

Descriptors: *Evapotranspiration, *Water hyacinth, *Reservoirs, *Water loss, *Texas, *Texas water plan, Floating plants, Vegetation effects, Aquatic plant control, Aquatic weeds.

Water hyacinth, an attractive, floating aquatic plant, poses a substantial threat of unanticipated water loss from Texas reservoirs. A mature plant will lose about three times as much water through evapotranspiration as is lost from evaporation of an equivalent area of open water. The reservoirs of east and southeast Texas, which comprise the bulk of the state's existing and planned water storage capacity, seem likely to suffer a 20% average surface infestation of water hyacinth. A coverage that great will result in a yearly net loss of over 2,000,000 acre-feet of impounded water, based on present water development plans for the state. This would amount to nearly 20% of the anticipated yield from the reservoirs affected. An effective aquatic plant control program could head off the threat of this significant water loss.

78:02D-005
CLIMATE, SOIL, AND VEGETATION 4. THE EXPECTED VALUE OF ANNUAL EVAPOTRANSPIRATION,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 731-739, October, 1978. 6 fig, 24 ref, 53 equ.

Descriptors: Evapotranspiration, Water balance, Infiltration, Soil moisture movement, Climatic data, Soil properties, Vegetation, Mathematical models, Surface runoff.

The depth of interstorm evapotranspiration from natural surfaces was composed (by proportion to vegetal canopy density) of evaporation from bare soil and transpiration from vegetation. The former was obtained in terms of random variables describing initial soil moisture, time between storms, and potential rate of evapotranspiration from an exfiltration analogy to the Philip infiltration equation modified to incorporate moisture extraction by plant roots. The latter was assumed to occur at the potential rate for natural vegetal systems. In a zeroth-order approximation the initial soil moisture was fixed at its climatic space and time average whereby using an exponential distribution of time between storms and a constant potential rate of evapotranspiration the expected value of interstorm evapotranspiration was derived. This mean value was used to obtain the annual average point evapotranspiration as a fraction of the potential value and as a function of dimensionless parameters defining the climate-soil-vegetation system.

78:02D-006
A COMPARISON OF TWO FORMULA TYPES FOR CALCULATING LONG-WAVE RADIATION FROM THE ATMOSPHERE,
Aase, J.K., and Idso, S.B.
Northern Plains Soil and Water Research Center, Sidney, Montana.
Water Resources Research, Vol. 14, No. 4, p 623-625, August, 1978. 1 fig, 1 tab, 14 ref, 3 equ.

Descriptors: Radiation, Thermal radiation, Solar radiation, Air temperature, Humidity, Vapor pressure, Estimating equations.

Measurements of long-wave radiation at Sidney, Montana, indicated that both an analytically derived equation and an empirically derived equation for clear-sky conditions adequately predict the long-wave radiation flux at that site for screen level air temperatures above 0°C. However, for air temperatures below 0°C, the analytical equation always underestimated the true radiation, while the empirical equation just slightly underestimated it, then match it, and then overestimated it, as air temperature decreased from 0°C to -37°C. These discrepancies in the below 0°C temperature regime indicated that the equations might need some modification to conform more closely to reality for low-temperature conditions.

78:02D-007
THE ROLE OF EVAPOTRANSPIRATION MODELS IN IRRIGATION SCHEDULING,
Jensen, M.E., and Wright, J.L.
Snake River Conservation Research Center, United States Department of Agriculture-Agricultural Research Service, Kimberly, Idaho.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21 SW, No. 1, p 82-87, February 20, 1978. 4 fig, 2 tab, 25 ref, 3 equ.

Descriptors: Scheduling, Irrigation, Evapotranspiration, Model studies, Soil moisture, Statistical methods.

Most evapotranspiration (ET) models are based on physical principles controlling evaporation and the conservation of mass and energy, and use daily climatic data. ET models coupled with irrigation models are valuable tools because they enable trained and experienced irrigation specialists to provide irrigation scheduling services at a reasonable cost. Estimated standard deviations of mean daily ET for 1- to 30-day periods at Akron, Colorado; Davis, California; Kimberly, Idaho; and Lompoc, California varied from 0.9 to 1.3 mm/day and it decreased to 0.4 to 0.7 mm/day for 15- to 30-day periods. Standard errors of ET estimates with a combination equation based on 243 days of data from Kimberly, Idaho were normally distributed and for daily values was 1.0 mm/day. This parameter decreased inversely with the square root of the number of days for up to 30 days and was similar to those reported for other areas using models that operate on daily climatic data. A summary of factors affecting confidence levels in irrigation scheduling was presented along with the expected standard deviations. Generally, the error in measuring soil moisture was generally smaller than estimated ET and irrigation application errors.

78:02D-008
DEVELOPMENT AND EVALUATION OF EVAPOTRANSPIRATION MODELS FOR IRRIGATION SCHEDULING,
Wright, J.L., and Jensen, M.E.
Snake River Conservation Research Center, Kimberly, Idaho.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 1, p 99-91, 96, February 20, 1978. 6 fig, 1 tab, 7 ref, 4 equ.

Descriptors: Evapotranspiration, Model studies, Scheduling, Irrigation, Lysimeters, Soil water.

Evapotranspiration (ET) data for irrigated crops in southern Idaho were used to develop relationships for estimating net radiation and potential ET for the USDA-ARS Computerized Irrigation Scheduling Program. ET estimated with the initial relationships compared well with recent measurements obtained with two sensitive weighing lysimeters. The average daily measured ET for alfalfa for 128 days when there was full cover was 7.23 mm, while the average daily estimated ET was 7.15 mm. Crop curve relationships were developed from the ET results for snap beans (Phaseolus vulgaris L.). The depletion of soil water was predicted for two years of irrigated beans with the scheduling program using the improved crop curves and compared with the measured as a test of its performance. The standard deviation of the difference between predicted and measured was about 0.95 mm/day from planting until harvest. The results also demonstrated the importance of obtaining representative meteorological data for irrigation scheduling.

SECTION V

WATER CYCLE

STREAMFLOW AND RUNOFF (GROUP 02E)

78:02E-001
SOME PROPERTIES OF VARIANCE REDUCTION TECHNIQUES WHERE HYDROLOGICAL EXTREMES ARE ESTIMATED BY MONTE CARLO SIMULATION,
Moore, R.J., and Clarke, R.T.
Institute of Hydrology, Wallingford, England.
Water Resources Research, Vol. 14, No. 1, p 55-61, February, 1978. 8 tab, 11 ref.

Descriptors: *Streamflow, *Model studies, *Mathematical models, *Monte Carlo method, *Synthetic hydrology, *Variance reduction, *Hydrological extremes, Regression analysis, Estimating, Probability.

An estimate F of a water resource system's performance, when it is derived by simulation using synthetic sequences, is subject to at least three errors; first, model errors, arising from the approximation to the "true" streamflow mechanism which the model represents; second, sampling errors in the model parameters theta when they are calculated from the historic records; and third, errors introduced by the Monte Carlo calculation from which F is derived. This paper presented some observations on the effects of the first two types of error on the estimate F but concentrated on the application of variance reduction techniques to the derivation of Monte Carlo estimates F for given theta. These techniques were, first, the use of control variates, and second, the use of antithetic variates. The application of the technique was illustrated by using some hypothetical examples of the calculation of probabilities of extreme hydrological events and of the calculation of reliability measures for a much oversimplified storage system. Considerable reduction in the variance of F resulted from the application of the control variate method; the reduction in Var F resulting from the use of antithetic variates was much less but still probably worth the small additional programming effort required. It was concluded that the promise of the control variate method suggests that it should be applied to assist in the efficient simulation of more realistic water resource systems than the trivial ones considered in this paper.

78:02E-002
A UNIFYING SET OF PROBABILITY TRANSFORMS FOR STOCHASTIC HYDROLOGY,
Snyder, W.M., Mills, W.C., and Knisel, W.G., Jr.
Agriculture Research Service, Athens, Georgia, Southeast Watershed Laboratory.
Water Resources Bulletin, Vol. 14, No. 1, p 83-98, February, 1978. 9 fig, 3 tab, 6 ref.

Descriptors: *Synthetic hydrology, *Statistics, *Probability, Model studies, Storms, Floods, Design storm, Statistical methods, Stochastic processes, Lognormal distributions.

An ordered set of probability density functions was derived from transforms of the normal distribution. Variate transforms were based on orders of exponentiation. The set of distributions included the log-normal. A partial basis for use of these functions in hydrology was demonstrated by establishing some required properties. A concept of mixed samples of zero and nonzero elements forming nonseparable sets of virtual and real elements was introduced to establish a physical lower limit of samples data independent of functional bounds.

78:02E-003
RIVER TRANSPORT MODELING FOR UNSTEADY FLOWS,
Keefer, T.N., and Jobson, H.E.
Sutron Corporation, Arlington, Virginia.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY5, Proceedings Paper 13735, p 635-647, May, 1978. 4 fig, 1 tab, 9 ref, 2 append.

Descriptors: *Streamflow, *Unsteady flow, *Mass transfer, *Georgia, *Chattahoochee River (Georgia), Model studies, Dye releases, River flow, Dispensing, Hydraulics.

Coupled flow-mass transport models were applied to a 17-mile (27.8-km) reach of the Chattahoochee River between Buford and Norcross, Georgia. Discharge variations from 550 cfs to 8,000 cfs (15 cu m/s to 100 cu m/s) in less than 20 min were analyzed. Accompanying stage variations were as much as 7 ft (2 m). Two data sets with 5-min time resolution were used to calibrate and verify the flow model. A longitudinal depth profile at steady low flow also was used in the calibration. Data from a 3-day continuous-injection dye study were used to verify the mass-transport model. The study demonstrated the feasibility of coupled models under highly unsteady flow conditions. The dye study demonstrated the unusual nature of conservative mass transport in unsteady flow. Both the flow and mass-transport models produced answers approaching the accuracy of the data. These are estimated as + or - 29 min in time, + or - 15%-20% for discharge, and + or - 0.5-ft (0.1-m) for stage.

78:02E-004
PRESERVATION OF THE RESCALED ADJUSTED RANGE 3. FRACTIONAL GAUSSIAN NOISE ALGORITHMS,
Hipel, K.W., and McLeod, A.I.
Waterloo University, Ontario, Department of Systems Design.
Water Resources Research, Vol. 14, No. 3, p 517-518, June, 1978. 14 ref.

Descriptors: *Computer models, *Mathematical models, *Hydrology, *Fractional Gaussian noise algorithms, *Rescaled adjusted range, Hurst coefficient, Time series analysis, Stochastic processes, Streamflow, Model studies.

Improved modeling procedures are available for use with a discrete time fractional Gaussian noise (FGN) model. These advancements in FGN modeling consist of an exact simulation procedure, a maximum likelihood approach to obtain efficient stimates of the model parameters, and a technique for calculating the model residuals so that they can be subjected to rigorous diagnostic checks. The computer algorithms for the aforementioned modeling improvements are available on microfiche. The intention of this article was to summarize the essential ingredients of the complete paper, which appears on microfiche.

78:02E-005
STREAM TEMPERATURE ESTIMATION USING KALMAN FILTER,
Chiu, C-L., and Isu, E.O.
Pittsburgh University, Pennsylvania, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY9, p 1257-1268, September, 1978. 4 fig, 16 ref, 33 equ, 2 append.

Descriptors: Water temperature, Streams, Mathematical models, Streamflow, Estimating, Forecasting, Stochastic processes.

The technique presented in this paper for estimating the daily streamflow temperature uses the Kalman filtering in which an observation and a (mathematical) system models were combined. The mathematical system model in turn combined a deterministic sinusoidal temperature model with a simple, stochastic (first-order autoregressive) model used to deal with the random deviation, from the actual temperature, of the temperature estimation given by the sinusoidal model. In this study the estimation and forecasting technique was tested for its capability to generate (predict or estimate) daily streamflow temperatures between measurements at several different measurement intervals ranging from 2 days to 15 days. The estimated temperatures were compared with the observed. The results showed several advantages of using Kalman filter over other existing models.

78:02E-006
CLIMATE, SOIL AND VEGETATION 5. A DERIVED DISTRIBUTION OF STORM SURFACE RUNOFF,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 741-748, October, 1978. 6 fig, 2 tab, 11 ref, 76 equ.
(See 78:02A-009)

78:02E-007
A FEATURE PREDICTION MODEL IN SYNTHETIC HYDROLOGY BASED ON CONCEPTS OF PATTERN RECOGNITION,
Panu, U.S., and Unny, T.E.
Waterloo University, Ontario, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 2, p 335-344, April, 1978. 7 fig, 4 tab, 23 ref.

Descriptors: *Synthetic hydrology, *Hydrologic data, *Model studies, *Stochastic processes, *Feature prediction model, *Saskatchewan River, Pattern recognition, Time series analysis, Methodology, Hydrology.

It is reasonable to consider that sequences of hydrologic data corresponding to daily, weekly, or monthly measurements occur in well-defined groups. These groups possess collective properties of the data forming them. Such a collection of properties can be called a hydrologic pattern. A pattern is a description of an object; and the objects of concern in this paper were groups of data on hydrologic phenomena observed at regular time intervals. Hydrologic patterns describing each of these groups are expressed by n appropriate properties. Further, the dimensionality, n in number, can be reduced by considering only those characteristic properties, m in number (m less than or = to n), that are common in all hydrologic patterns of the same category. These m characteristic properties are called features. A procedure was presented to extract information present within patterns and among patterns of the pertinent hydrologic data. In addition, on the basis of the above information, a zero-order Markov feature prediction model was postulated. The basic assumptions of the model and their implications were presented. The model was applied to South Saskatchewan River flow data in an effort to demonstrate its usefulness in real situations.

78:02E-008
PRESERVATION OF THE RESCALE ADJUSTED RANGE 1. A REASSESSMENT OF THE HURST PHENOMENON,
McLeod, A.I., and Hipel, K.W.
University of Western Ontario, London, Department of Mathematics.
Water Resources Research, Vol. 14, No. 3, p 491-508, June, 1978. 8 fig, 10 tab, 67 ref.

Descriptors: *Model studies, *Mathematical models, *Hydrology, *Rescaled adjusted range, Stochastic processes, Mathematics, Streamflow, River flow, Time series analysis, Simulation analysis.

Previous research related to the controversial Hurst phenomenon was reviewed and evaluated. Because of the inherent statistical properties of the rescaled adjusted range (RAR) statistic, it was suggested that research primarily be devoted to this statistic rather than to the various definitions of the Hurst coefficient. Simulation studies revealed that for independently distributed random variables the RAR does not depend significantly on the underlying distribution of the random variables but is a function of the sample size. For modeling correlated data, the statistical attributes of a discrete fractional Gaussian noise (FGN) process were studied and also improved. An efficient maximum likelihood estimation technique was developed for the FGN model, and it was shown how the residuals of the fitted model can be calculated and then subjected to diagnostic checks. An exact simulation procedure was developed for simulating FGN in such a way that synthetic traces from the model lie outside the Brownian domain. The Akaike information criterion (AIC) was suggested as a method for choosing between a FGN and a Box-Jenkins model. For the six annual river flow series that were considered, the AIC selected the best Box-Jenkins model in preference to the FGN process for each data set. Because Box-Jenkins models can be shown to preserve the historical RAR, in many practical applications it may be advantageous to use a Box-Jenkins model instead of a FGN process.

78:02E-009
PRESERVATION OF THE RESCALED ADJUSTED RANGE 2. SIMULATED STUDIES USING BOX-JENKINS MODELS,
Hipel, K.W., and McLeod, A.I.
Waterloo University, Ontario, Department of Systems Design.
Water Resources Research, Vol. 14, No. 3, p 509-516, June, 1978. 6 tab, 34 ref.

Descriptors: *Model studies, *Mathematical models, *Hydrology, *Box-Jenkins models, *Rescaled adjusted range, Stochastic processes, Mathematical studies, Monte Carlo method, Time series analysis, Geophysics.

It was demonstrated that autoregressive moving average (Arma) models do preserve the rescaled adjusted range (RAR), or equivalently the Hurst coefficient K. Arma models were fitted to 23 geophysical time series, and by using Monte Carlo techniques and a specified statistical test it was shown that the observed RAR or K is retained by the models. The empirical cumulative distribution function (ECDF) for these statistics can be calculated as closely as is required to the theoretical distribution. Furthermore, the distribution of the RAR is a function of the time series length N and the parameter values of the particular Arma process being considered. Various estimates for the Hurst coefficient were compared for the 23 geophysical data sets.

78:02E-010
DISCHARGE-DEPTH EQUATION FOR SHALLOW FLOW,
Turner, A.K., Langford, K.J., Win, M., and Clift, T.R.
Melbourne University, Parkville, Australia, Department of Civil Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, Proceedings Paper 13626, p 95-110, March, 1978.
9 fig, 3 tab, 20 ref, 2 append.

Descriptors: *Flow, *Overland flow, *Roughness (hydraulic), *Model studies, Vegetation, Crops, Soils, Sheet flow, Retardance, Surface runoff, Equations.

The application of a discharge-depth equation (with variable coefficient and exponent) was recommended for shallow flows of water over soil and through vegetation. The more flexible nature of this equation over the commonly used channel flow equations was considered, and typical values were given for three conditions, viz, bare uneven soil, artificial vegetation, and pasture and crop covers growing on a sandy soil.

78:02E-011
RESIDUE AND TILLAGE EFFECTS ON SCS RUNOFF CURVE NUMBERS,
Rawls, W.J., and Onstad, C.A.
Hydrology Laboratory, Science and Education Administration, Agricultural Research, Beltsville, Maryland, United States Department of Agriculture.
Paper No. 78-2505, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 18 p. 5 fig, 7 tab, 22 ref.

Descriptors: Runoff, Surface runoff, Soil conservation, Till, Rainfall, Simulated rainfall, Estimating, Small watersheds, Corn (field), Grains (crops).

Data from 525 simulated and natural rainfall events were used to develop guides for estimating the effect of conservation tillage practices on the SCS runoff curve numbers for corn and small grain. The amount of residue on the ground or the percent of surface covered with residue was used to represent the effect of conservation tillage practices.

SECTION VI

WATER CYCLE

GROUNDWATER (GROUP 02F)

78:02F-001
POROUS MEDIA TESTS OF GROUNDWATER MOUNDS,
Mousavi, S.-F., Kirkham, D.
Iowa State University, Ames, Department of Agronomy.
Soil Science Society of America Journal, Vol. 125, No. 3, p 160-164, March, 1978. 8 fig, 14 ref.

Descriptors: *Model studies, *Porous media, *Groundwater recharge, Pit recharge, Equations, Testing, Laboratory tests, Hydraulic conductivity, Infiltration, Groundwater mounds.

To test the theoretical equations for the shapes of groundwater mounds formed under rectangular and circular recharge basins, two Plexiglas laboratory models were constructed. Glass beads, white silica sand, and gravel were used as porous media, and a 60% glycerol-water mixture was used as the recharge fluid. The mound heights, measured at various distances from the centers of the mounds, were compared with the theoretical mound heights. The experimental mound heights showed good agreement with theoretical ones, both for the two-dimensional and the three-dimensional axial symmetric mounds.

78:02F-002
EFFECTS OF CORN STOVER, MANURE, AND NITROGEN ON SOIL PROPERTIES AND CROP YIELD,
Ketcheson, J.W., and Beauchamp, E.G.
Guelph University, Canada, Department of Land Resource Science.
Agronomy Journal, Vol. 70, No. 5, p 792-797, September-October, 1978. 4 fig, 8 tab, 6 ref.

Descriptors: Nitrogen, Fertilizers, Corn (field), Organic matter, Farm wastes, Soil properties, Crop response, Soil treatment.

Residues and farmyard manures are considered important in determining the N fertilizer requirement of crops. This relationship was studied in a 10-year field experiment on a Typic Hapludalf soil (pH 7.8). Five levels of fertilizer N were applied annually with three management treatments which included 1) returning the stover produced by the preceding corn (Zea mays L.) crop, 2) poultry manure equivalent to 112 kg N/ha/year and 3) no stover returned or manure applied. Dry matter yields and N in grain and stover were measured each year. In general, the manure treatment without N fertilizer gave yields comparable with any other treatment. Where fertilizer N was applied, stover resulted in slightly higher yields than where stover was removed. Stover returned to the soil did not increase fertilizer N requirements at normal rates of application. It was concluded that corn stover residue did not affect the N fertilizer requirement of this soil for grain corn production. Annual applications of liquid poultry manure, containing N equivalent to 112 kg/ha, precluded a requirement for fertilizer N.

78:02F-003
AN APPROXIMATE DIFFERENTIAL EQUATION TO DESCRIBE LEAKY AQUIFER BEHAVIOR DURING INTERMEDIATE AND LARGE VALUES OF TIME,
Rodarte, L.
Universidad Nacional Autonoma de Mexico, Mexico City, Department of Ingeniera.
Water Resources Research, Vol. 14, No. 1, p 39-44, February, 1978. 6 fig, 12 ref.

Descriptors: *Aquifers, *Groundwater, *Model studies, *Leaky aquifers, Mathematical models, Equations, Leakage, Flow, Pumping, Drawdown.

In analyzing a leaky aquifer for application in regional studies, it is of great interest to have available simplified mathematical representations from which an analogical or digital model of the problem can be constructed. In this paper, a differential equation valid for intermediate and large values of time was proposed. Also, an analytical solution corresponding to an isolated well as a test of the range of applicability of the proposed equation was obtained.

78:02F-004
THEORY AND NUMERICAL ANALYSIS OF MOVING BOUNDARY PROBLEMS IN THE HYDRODYNAMICS OF POROUS MEDIA,
Nakano, Y.
Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire.
Water Resources Research, Vol. 14, No. 1, p 125-134, February, 1978. 4 fig, 5 tab, 14 ref.

Descriptors: *Mathematical studies, *Theoretical analysis, *Numerical analysis, *Boundaries (surfaces), *Porous media, Equations, Groundwater movement, Moving boundaries.

The exact mathematical description of a boundary between unsaturated flow and saturated flow as well as a wetting front were obtained. A new concept for numerical analysis of flow in partly unsaturated and partly saturated porous medium was introduced. A boundary of infinitesimal width intersecting the unsaturated and saturated parts was substituted by an artificial transitional zone of finite width for computational simplicity. The concept was proved to be theoretically justificable. The feasibility of the concept was demonstrated as it was applied to a two-dimensional finite difference solution of a special problem of column drainage, for which an analytical solution was obtained.

78:02F-005
LAS VEGAS VALLEY WATER BUDGET: RELATIONSHIP OF DISTRIBUTION, CONSUMPTIVE USE, AND RECHARGE TO SHALLOW GROUNDWATER,
Patt, R.O.
Desert Research Institute, Las Vegas, Nevada 89109.
Publication No. EPA-600/2-78-159, July, 1978. 61 p, 16 fig, 8 tab, 19 ref, 3 append.

Descriptors: Groundwater, Groundwater recharge, Water consumption.

Estimates of quantity and geographic distribution of recharge to the shallow groundwater zone from water use return flows in Las Vegas Valley were made for the years 1973, 1965, 1958, 1950, and 1943 as part of a broader study on the impact of water and land use on groundwater quality. Considered components of water use in Las Vegas Valley include the following: supply from surface and groundwater; agriculture using potable water; agriculture using sewage effluent; residential lawn watering; lawn watering of parks, schools, cemetaries, hotels, motels; golf courses using potable water; golf courses using sewage effluent water; septic tank recharge; evaporative coolers; system losses' industrial use; power plant cooling; swimming pool use; consumptive use by phreatophytes; invalley recharge from precipitation, and "unaccounted for water". Consumptive use of plants was calculated through use of the Blaney-Criddle method as 3.47 feet per year and recharge was assumed to be the difference between applied water and calculated consumptive use. Data developed during this study indicates consumptive use as determined by this method could be low by 1.5 to 2 feet per year, and thus the following estimates of recharge to the groundwater system are considered maximum, in acre feet: 1973-39,000; 1965-27,600; 1958-26,650; 1950-13,000; and 1943-21,000.

78:02F-006
NUMERICAL MODEL FOR SATURATED-UNSATURATED FLOW IN DEFORMABLE POROUS MEDIA.
2. THE ALGORITHM,
Narasimhan, T.N., Witherspoon, P.A., and Edwards, A.L.
California University, Berkeley, Lawrence Berkeley Laboratory.
Water Resources Research, Vol. 14, No. 2, p 255-261, April, 1978. 3 fig, 8 ref.

Descriptors: *Numerical analysis, *Mathematical models, *Porous media, *Saturated flow, *Unsaturated flow, *Algorithms, *Integrated-finite-difference method, Equations, Groundwater movement, Aquifer characteristics.

An integrated finite difference algorithm was presented for numerically solving the governing equation of saturated-unsaturated flow in deformable porous media. In recognition that stability of the explicit equation is a local phenomenon, a mixed explicit-implicit procedure was used for marching in the time domain. In this scheme, the explicit changes in potential are first computed for all elements in the system, after which implicit corrections are made only for those elements for which the stable time step is less than the time step being used. Time step sizes are controlled automatically in order to optimize the number of iterations, to control maximum change in potential during a time step, and to obtain desired outputs. Time derivatives, estimated on the basis of system behavior during two previous time steps, are used to start the iteration process and to evaluate nonlinear coefficients. Boundary conditions and sources can vary with time or with the dependent variable. Input data are organized into convenient blocks. Accuracy of solutions can be affected by modeling errors, different types of truncation errors, and convergence errors. The algorithm constitutes an efficient tool for analyzing linear and nonlinear fluid flow problems in multidimensional heterogeneous porous media with complex geometry. An important limitation is that the model cannot conveniently handle arbitrary anisotropy and other general tensorial quantities.

78:02F-007
STOCHASTIC ANALYSIS OF SPATIAL VARIABILITY IN SUBSURFACE FLOWS. 1. COMPARISON OF ONE- AND THREE-DIMENSIONAL FLOWS,
Bakr, A.A., Gelhar, L.W., Gutjahr, A.L., and MacMillan, J.R.
New Mexico Institute of Mining and Technology, Socorro.
Water Resources Research, Vol. 14, No. 2, p 263-271, April, 1978. 4 fig, 23 ref.

Descriptors: *Stochastic processes, *Hydraulic conductivity, *Subsurface flow, *Aquifers, Groundwater movement, Statistical models, Equations, Hydraulic gradient, Mathematical models, Monte Carlo method.

The complex variation of hydraulic conductivity in natural aquifer materials is represented in a continuum sense as a spatial stochastic process which is characterized by a covariance function. Assuming statistical homogeneity, the theory of spectral analysis was used to solve perturbed forms of the stochastic differential equation describing flow through porous media with randomly varying hydraulic conductivity. From analyses of unidirectional mean flows which are perturbed by one- and three-dimensional variations of the logarithm of the hydraulic conductivity, local relationships between the head variance and the log conductivity variance were obtained. The results showed that the head variance produced by three-dimensional statistical isotropic conductivity perturbations is only 5% of that in the corresponding one-dimensional case. The head variance is also strongly dependent on the correlation distance of the log conductivity covariance function. These results emphasized the importance of including spatial correlation structure and multidimensional effects in stochastic simulation of groundwater flow.

78:02F-008
AN EFFICIENT NUMERICAL METHOD OF TWO-DIMENSIONAL STEADY GROUNDWATER PROBLEMS,
Liu, P.L.-F., and Liggett, J.A.
Cornell University, Ithaca, New York, School of Civil and Environmental Engineering.
Water Resources Research, Vol. 14, No. 3, p 385-390, June, 1978. 6 fig, 2 tab, 11 ref.

Descriptors: *Groundwater movement, *Groundwater, *Model studies, Mathematical models, Seepage, Dams, Earth dams, Saline water intrusion, Saline water-freshwater interfaces, Aquifers.

The boundary integral equation method (BIEM) was shown to be an efficient and accurate numerical technique for solving problems of Darcy flow in porous media. The BIEM was combined with conformal transformation to the complex potential plane to solve free surface problems without iteration and with relatively few nodal points. Since the BIEM reduces the effective dimensions of the problem by one, the computer time varies approximately as the inverse square of the point spacing; whereas in finite element or finite difference methods; the time varies approximately as the inverse of the 4th power of the point spacing. Two examples of the BIEM were presented: flow through an underdrained dam, and a seawater intrusion problem.

78:02F-009
THEORY OF FLOW IN UNCONFINED AQUIFERS BY INTEGRODIFFERENTIAL EQUATIONS,
Herrera, I., Minzoni, A., and Flores, E.Z.
Universidad Nacional Autonoma de Mexico, Mexico City, Centro de Investigaciones en Matematicas Aplicadas y en Sistemas.
Water Resources Research, Vol. 14, No. 2, p 291-297, April, 1978. 3 fig, 1 tab, 18 ref, 1 append.

Descriptors: *Aquifers, *Drawdown, *Theoretical analysis, *Mathematical models, Groundwater movement, Unsteady flow, Groundwater, Flow, Compressible flow, Porous media.

It was shown that when the diffusion of the deviation of the drawdown from its average value can be neglected, the unsteady flow in unconfined aquifers is governed by an integrodifferential equation. For incompressible flow, this equation reduces the Boulton's delayed yield equation with epsilon = 3. When the flow is compressible, the kernel can be approximated by Boulton's delayed factor in a range of times whose lower limit approaches zero with the compressibility.

78:02F-010
STEADY PHREATIC FLOW OVER A SLOPING SEMIPERVIOUS LAYER,
Mualem, Y., and Bear, J.
Colorado State University, Fort Collins, Engineering Research Center.
Water Resources Research, Vol. 14, No. 3, p 403-408, June, 1978. 7 fig, 10 ref.

Descriptors: *Groundwater movement, *Groundwater, *Model studies, Mathematical models, Boundary layers, Impervious soils, Flow, Steady flow, Slopes, Equations.

This work dealt with steady phreatic flow above a thin semipervious sloping layer located at some distance below ground surface and above the water table of an underlying phreatic aquifer. Cases of both upsloping and downsloping semipervious layers were studied. A uniform recharge of constant rate and a semipervious layer of finite length were considered, either with length of flow shorter than the semipervious layer with flow bypassing its edge. For each case, linearization was applied to the nonlinear continuity equation which governs the flow. Analytical solutions were derived then for the shape of the phreatic flow wedge, the length of the wedge, and the discharge rate. These results were compared with experimental ones obtained in a Hele-Shaw analog. A good agreement generally was found between computed and observed results. Because of the analogy which exists between a phreatic surface and an interface in a coastal aquifer, the same results also can be applied to the steady freshwater flow above an interface in an aquifer divided into two subaquifers by a sloping semipervious layer.

78:02F-011
SENSITIVITY OF OPTIMIZED PARAMETERS IN WATERSHED MODELS,
Mein, R.G., and Brown, B.M.
Monash University, Clayton, Australia, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 2, p 299-303, April, 1978. 1 fig, 2 tab, 12 ref.

Descriptors: *Model studies, *Watersheds (basins), *Simulation analysis, *Methodology, *Hydrologic data, *Boughton model, Analytical techniques, Statistics, Optimization, Forecasting.

Models which attempt to simulate specifically each of the important hydrologic components of the watershed response appear to have more potential than black box models for predicting the effect of land use change, for application to ungaged watersheds, and for general studies of the effects of each process on watershed runoff. It has been common practice to evaluate some or all parameters of watershed models by fitting procedures. A methodology was presented by which the variance of each fitted parameter of a watershed model can be determined. This information can be used to determine the degree to which the model parameters can be related to physical characteristics. The method was illustrated by applying the Boughton model to several watersheds and by examining the coefficient of variation of each optimized parameter.

78:02F-012
UNSTEADY FLOW TO A PUMPED WELL IN A FISSURED AQUIFER WITH A FREE SURFACE LEVEL MAINTAINED CONSTANT,
Boulton, N.S., and Streltsova, T.D.
Sheffield University, England, Department of Civil and Structural Engineering.
Water Resources Research, Vol. 14, No. 3, p 527-532, June, 1978. 6 fig, 2 tab, 6 ref.

Descriptors: *Aquifers, *Pumping, *Drawdown, *Model studies, Mathematical models, Groundwater, Groundwater movement, Flow, Fissures (geologic), Water levels, Equations.

New equations were derived for the drawdown in an aquifer consisting of two horizontal layers referred to as the block and the fissure, which have different hydraulic properties. The free water surface forming the upper aquifer boundary was located in the block. The water level was assumed to remain constant during pumping. The block and the fissure were compressible. The depth of the fissure was small in comparison with that of the block. The abstraction well, lined along the block, was pumped at a constant rate. The discharge per unit length of the unlined part in the fissure was constant, and the radius of the well was vanishingly small. Type curves for the drawdown in the fissure and the block were computed and plotted for some selected parameters involved. The effect of the block compressibility on the drawdown in the fissure was shown by comparing the type curves with the type A drawdown curves of Boulton. The influence of the free surface compared with that of an impervious top layer on the drawdown in the fissure and the block was estimated by comparing the type curves with those of Boulton and Streltsova found from the equations for a two-layered formation, the top and bottom surfaces of which were impermeable.

78:02F-013
ANALYSIS OF DYNAMIC AQUIFERS WITH STOCHASTIC FORCING FUNCTION,
Sagar, B.
Department of the Environment, Ottawa, Ontario, Hydrology Research Division; and Department of the Environment, Ottawa, Ontario, Inland Waters Directorate.
Water Resources Research, Vol. 14, No. 2, p 207-216, April, 1978. 6 fig, 28 ref.

Descriptors: *Saturated flow, *Aquifers, *Mathematical models, *Stochastic processes, Model studies, Mathematical studies, Analytical techniques, Analysis, Flow, Porous media.

The existence of different types of uncertainties in deterministic aquifer models and the need of quantitatively accounting for them were discussed. The case of one-dimensional saturated flow represented by a linear parabolic partial differential equation with a stochastic forcing function was analyzed. The dependence of the autocovariance function of the hydraulic head on properties of the forcing function and nature of the aquifer was brought out.

78:02F-014
A FINITE ELEMENT STUDY OF STEADY STATE FLOW IN AN UNCONFINED AQUIFER RESTING ON A SLOPING BED,
Choi, E.C.C.
Hong Kong University, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 3, p 391-394, June, 1978. 5 fig, 3 tab, 12 ref.

Descriptors: *Aquifers, *Groundwater movement, *Model studies, Mathematical models, Finite element analysis, Beds, Boundary layers, Impervious soils, Groundwater, Seepage, Flow, Slopes, Hydrology, Impermeable beds.

A two-dimensional finite element method was used to study the problem of seepage over a sloping impermeable bed. Flow profile and seepage rates obtained from the analysis were compared with those solved from Pavlovsky's and Childs' equations. The latter equation was found to be more favorable, especially for large slopes. The effects on the flow profile due to a change in the upstream and downstream conditions and to a sudden change in the magnitude of the slope to the impermeable bed also were investigated.

78:02F-015
NUMERICAL SIMULATION OF STEADY STATE THREE-DIMENSIONAL GROUNDWATER FLOW NEAR LAKES,
Winter, T.C.
Geological Survey, Denver, Colorado, Water Resources Division.
Water Resources Research, Vol. 14, No. 2, p 245-254, April, 1978. 14 fig, 8 ref.

Descriptors: *Groundwater movement, *Lakes, *Seepage, *Surface-groundwater relationships, *Three-dimensional simulation analysis, *Lake-water budget, Model studies, Numerical analysis, Simulation analysis, Hydrogeology.

Numerical simulation of three-dimensional groundwater flow near lakes shows that the continuity of the boundary encompassing the local groundwater flow system associated with a lake is the key to understanding the interaction of a lake with the groundwater system. The continuity of the boundary can be determined by the presence of a stagnation zone coinciding with the size of the lake nearest the downgradient side of the groundwater system. For most settings modeled in this study the stagnation zone underlies the lakeshore, and it generally follows its curvature. The length of the stagnation zone is controlled by the geometry of the lake's drainage basin divide on the side of the lake nearest the downgradient side of the groundwater system. In the case of lakes that lose water to the groundwater system, three-dimensional modeling also allows for estimating the area of lake bed through which outseepage takes place. Analysis of the effects of size and lateral and vertical distribution of aquifers within the groundwater system on the outseepage from lakes shows that the position of the center point of the aquifer relative to the littoral zone on the side of the lake nearest the downgradient side of the groundwater system is a critical factor. If the center point is downslope from this part of the littoral zone, the local flow system boundary tends to be weak or outseepage occurs. If the center point is upslope from this littoral zone, the stagnation zone tends to be stronger (to have a higher head in relation to lake level), and outseepage is unlikely to occur.

78:02F-016
NON-STEADY SPHERICAL FLOW TO A CAVITY WELL IN AN INFINITE NON-LEAKY AQUIFER,
Kanwar, R.S., and Chauhan, H.S.
Iowa State University, Ames, Department of Agricultural Engineering.
Water Resources Bulletin, Vol. 14, No. 3, p 605-612, June, 1978. 1 fig, 10 ref.

Descriptors: *Groundwater, *Groundwater movement, *Water wells, *Model studies, Mathematical models, Equations, Aquifers, Wells, Drawdown, Hydraulic conductivity.

The non-steady drawdown distribution near a cavity well discharging from an infinite non-leaky artesian aquifer was presented. The variation of drawdown with time and distance caused by a cavity well of constant discharge in a confined aquifer of uniform thickness and uniform permeability was obtained. The solution was expressed in a series form which converged rapidly so that only two terms of the series are needed to obtain an accuracy of more than 95%. A simplified approach was suggested to find the aquifer characteristics.

78:02F-017
A NOTE ON PACKER, SLUG, AND RECOVERY TESTS IN UNCONFINED AQUIFERS,
Dagan, G.
Tel Aviv University, Ramat-Aviv, Israel, School of Engineering.
Water Resources Research, Vol. 14, No. 5, p 929-934, October, 1978. 3 fig, 1 tab, 4 ref, 45 equ.

Descriptors: Water table aquifers, Hydraulic conductivity, Permeability, Well data, Steady flow, Numerical analysis.

Packer, slug, and recovery tests are common procedures for determining the hydraulic conductivity of unconfined formations of low permeability. The volumes of water injected or removed from the borehole are small, so that the water table remains horizontal and the flow is steady. The flow problem is solved by source distributions along the well axis. A simple numerical method and numerical results covering a wide range of the parameters of the problem were presented. The main limitation of the method is the requirement that the active portion of the well length should be much larger (say, 50 times) than the well radius.

78:02F-018
STEADY-STATE DRAWDOWNS IN COUPLED AQUIFERS,
Motz, L.H.
Geraghty and Miller, Inc., Tampa, Florida.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY7, Proceedings Paper 13886, p 1061-1074, July,1978. 8 fig, 1 tab, 14 ref.

Descriptors: *Aquifers, *Leakage, *Drawdown, *Mathematical models, Equations, Groundwater movement, Pumping, Steady flow, Evapotranspiration, Water resources.

The analytical linear solution that predicts the steady-state drawdowns for a coupled two-aquifer system in which pumping from an underlying artesian aquifer is balanced by a reduction in evapotranspiration from an overlying water-table aquifer was developed. An example illustrating how the drawdown equations can be used to determine whether significant drawdowns will occur in the water-table aquifer was presented. These drawdown equations can be used for preliminary analysis and planning studies and to test the convergence of digital model solutions when these more sophisticated techniques are warranted. A major limitation to using these equations is that the predicted water table drawdowns cannot be so great that evapotranspiration would cease altogether and, thus, could not be reduced any further to balance the pumping.

78:02F-019
SOLUTIONS OF BOUSSINESQ'S EQUATION FOR SEEPAGE FLOW,
Gureghian, A.B.
Argonne National Laboratory, Illinois, Division of Environmental Impact Studies.
Water Resources Research, Vol. 14, No. 2, p 231-236, April, 1978. 6 fig, 2 tab, 19 ref.

Descriptors: *Seepage, *Equations, *Groundwater, *Boussinesq's equation, Seepage control, Ditches, Finite element analysis, Hydrology, Soils, Channels.

Solutions of Boussinesq's equation for groundwater seepage from a ditch with vertical sides extending in depth to a horizontal impermeable floor were obtained numerically by using the finite difference and finite element methods for the case when the seepage rate from the ditch into the soil is constant with time. Both solutions agreed satisfactorily with experimental results from a Hele-Shaw analog. It was found, however, that the execution time in the computer for the finite difference method was an order shorter than that for the finite element method, and thus the finite difference method is to be preferred. The finite difference method also was used to obtain a numerical solution for the reverse situation when water seeps out of the soil into the ditch at a constant rate.

78:02F-020
GROWTH OF GROUNDWATER MOUNDS AFFECTED BY IN-TRANSIT WATER,
Ortiz, N.V., McWhorter, D.B., Sunada, D.K., and Duke, H.R.
Colorado State University, Fort Collins, Engineering Research Center.
Water Resources Research, Vol. 14, No. 6, p 1984-1088, December, 1978. 8 fig, 13 ref.

Descriptors: Groundwater, Water table, Aquifers, Storage capacity, Analytical techniques, Numerical analysis, Porous media, Water table, Aquifers.

An analytical solution accounting for the reduction in storage capacity caused by intransit water was presented for the growth of groundwater mounds in an unconfined aquifer in response to uniform deep percolation from a strip of infinite length but finite width. The solution was obtained by integrating the solution for the analogous case of heat flow in a composite solid with respect to time. The aquifer was considered to be homogeneous, isotropic, and infinite in areal extent and rested on a horizontal impermeable base. The results from the analytical solution were compared with those obtained from a numerical model which was previously verified with data obtained from a physical porous media model. Dimensionless curves were presented to afford a relatively simple means of analyzing the growth of groundwater mounds.

78:02F-021
ON THE DETECTION OF SHALLOW AQUIFERS USING THERMAL INFRARED IMAGERY,
Huntley, D.
Connecticut University, Storrs, Department of Geology and Geophysics.
Water Resources Research, Vol. 14, No. 6, p 1075-1083, December, 1978. 11 fig, 21 ref.

Descriptors: Aquifers, Groundwater, Shallow water, Depth, Remote sensing, Infrared radiation, Radiation, Temperature, Diurnal, Geophysics.

The existence of a tool (the thermal infrared scanner) that primarily records the spatial variation in surface temperature, combined with a consideration of the effect of an aquifer on subsurface heat flow patterns, has led several investigators of remote sensing capabilities to look for relations between the distribution of aquifers and radiometric temperatures. Because of the obvious potential significance of the ability to detect aquifers remotely, this author investigated the theoretical and practical basis for aquifer detection. The purpose of this research was (1) to determine the effect of varying aquifer depth on diurnal surface temperature, (2) to compare the effects produced by varying aquifer depth to those of varying soil type and soil moisture, and (3) to determine the optimum interpretive techniques for location of shallow aquifers using thermal infrared imagery. The results of this investigation led to the following conclusions: (1) with present technology, it is not practical to estimate groundwater depth directly using thermal infrared imagery, (2) correlations between groundwater depth and radiometric temperature noted in the literature are likely caused by increased evaporative cooling related to increased soil moisture, (3) estimation of evaporation from thermal infrared imagery acquired during both day and night may be feasible.

78:02F-022
AN ITERATIVE QUASI-THREE-DIMENSIONAL FINITE ELEMENT MODEL FOR HETEROGENEOUS MULTIAQUIFER SYSTEMS,
Chorley, D.W., and Frind, E.O.
Waterloo University, Ontario, Canada N2L 3G1.
Water Resources Research, Vol. 14, No. 5, p 943-952, October, 1978. 11 fig, 2 tab, 27 ref, 25 equ, 1 append.

Descriptors: Groundwater movement, Finite element analysis, Aquifer systems, Aquitards, Model studies, Mathematical models, Analytical techniques, Economic justification.

A quasi-three-dimensional flow model was developed for the analysis of hydrogeologic systems consisting of several aquifers interconnected by aquitards. Provided only that each layer was continuous within the domain and that a permeability contrast of two orders of magnitude or more existed between adjoining layers, a system could be completely heterogeneous. Any of the aquifers could be pumped, and discharge rates could be arbitrary. Flexibility was iterative, solving aquifers and aquitards separately and providing coupling through the leakage flux. Aquitard storage and interaction between aquifers were rigorously accounted for at all times. Convergence was demonstrated experimentally by comparison with the analytical solution of Neuman and Witherspoon (Publ. 69-1, Dept. of Civil Eng., Univ. of Calif., Berkeley, 1969). The multiaquifer model was shown to be much more economical than an equivalent three-dimensional model.

78:02F-023
STOCHASTIC ANALYSIS OF SPATIAL VARIABILITY IN SUBSURFACE FLOWS 2. EVALUATION AND APPLICATION,
Gutjahr, A.L., Gelhar, L.W., Bakr, A.A., and MacMillan, J.R.
New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801.
Water Resources Research, Vol. 14, No. 5, p 953-959, October, 1978. 5 fig, 9 ref, 52 equ.

Descriptors: Subsurface flow, Groundwater movement, Stochastic processes, Spatial distribution, Porous media, Approximation method, Hydraulic conductivity, Network design, Aquitards.

The stochastic differential equation describing one-dimensional flow in a statistically homogeneous porous medium was solved exactly, and the results were compared with an approximate solution considering small perturbations in the logarithm of the hydraulic conductivity. The results showed that the logarithmic approximation is valid when the standard deviation of the natural logarithm of the hydraulic conductivity, sigma sub f, is less than 1; the errors increase rapidly for sigma sub f > 1. The effective hydraulic conductivity of statistically homogeneous media with one-, two- and three-dimensional perturbations was determined to the first order in the square of sigma sub f (SSF). The effective conductivity was found to be the harmonic mean for one-dimensional flow, the geometric mean for two-dimensional flow, and (1 + SSF/6) times the geometric mean for three-dimensional flow. The application of stochastic analysis was illustrated through two elementary network design problems that demonstrate the importance of the correlation length of the hydraulic conductivity and the role of measurement error.

78:02F-024
THE COMPUTATIONAL EFFICIENCY AND TAYLOR EXPANSION DERIVATION OF APPROXIMATING EQUATIONS TO THE GROUNDWATER FLOW EQUATION,
Kuiper, L.K.
Ahmadu Bello University, Zaria, Nigeria, Department of Physics.
Water Resources Research, Vol. 14, No. 6, p 1171-1181, December, 1978. 8 fig, 2 tab, 12 ref, 52 equ.

Descriptors: Groundwater movement, Approximation method, Finite element analysis, Numerical analysis, Mathematical studies, Groundwater.

In this paper, the relative accuracy and speed of 12 different approximations for the solution of the homogeneous one-dimensional groundwater flow equation were compared. Two of these approximations were derived by the use of finite elements including both the time and the spacial domain, others by the use of finite elements in the spacial domain and finite differences in the time domain, and the remainder by the use of finite differences in both the time and the spacial domain. Several generalizations of these approximations for use with the nonhomogeneous one-dimensional groundwater flow equation were also compared for accuracy. A general procedure for the derivation of approximations to differential equations was presented.

78:02F-025
GALERKIN FINITE ELEMENT PROCEDURE FOR ANALYZING FLOW THROUGH RANDOM MEDIA,
Sagar, B.
Punjab Agricultural University, Ludhiana 141004, India, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 6, p 1035-1044, December, 1978. 3 fig, 2 tab, 19 ref, 28 equ.

Descriptors: Groundwater movement, Flow around objects, Porous media, Stochastic processes, Finite element analysis, Mathematical studies, Statistical methods.

A method was presented for analyzing flow through a porous medium whose parameters are random functions. Such a medium was conceptualized as an ensemble of media with an associated probability mass function. The flow problem in each member of this ensemble is deterministic in the usual sense. All the solutions belong to a particular Hilbert space, and hence they can be written in terms of linear combinations of its basis functions. This is similar to the Galerkin formulation except that the coefficients in the linear combination are no longer deterministic quantities but random functions. The finite element method in conjunction with a Taylor series expansion was used to get the first two moments of the solution approximately. The method does not require specification of full probability mass functions of the parameters but only their first two moments, and spatial correlations can be easily accounted for. However, it was assumed that the probability mass functions are peaked at the expected value and are smooth in its vicinity. A sample problem was solved to illustrate the procedure. It was observed that the result is sensitive to the element size in the numerical scheme and the variances and spatial correlations of parameters. The expected value of the hydraulic head was found to differ significantly from the results that would have been obtained if the problem had been solved deterministically.

78:02F-026
THE CARBON ISOTOPE GEOCHEMISTRY OF A SMALL GROUNDWATER SYSTEM IN NORTHEASTERN ONTARIO,
Fritz, P., Reardon, E.J., Barker, J., Brown, R.M., and Cherry, J.A.
Waterloo University, Waterloo, Ontario, Canada, Department of Earth Sciences.
Water Resources Research, Vol. 14, No. 6, p 1059-1067, December, 1978. 5 fig, 5 tab, 23 ref.

Descriptors: Isotope studies, Carbon, Geochemistry, Carbon dioxide, Carbonate rocks, Groundwater, Crystalline rocks, Isotope fractionation, Canada.

The carbon isotopic composition (13C and 14C) of the inorganic carbon dissolved in the waters of a small, largely unconfined aquifer in unconsolidated sediments on the Canadian Shield was investigated. Three principal carbon sources were recognized: soil CO2, rock carbonate, and biogenic CO2. The average delta-13C value of the soil CO2 was close to -21.0 ± 1.5, and present-day 14C activities of the soil CO2 varied between 130 and 162% modern 14C. Very minor amounts (<1.0%) of carbonate minerals were present within the aquifer and reacted with this soil CO2 to produce a dissolved inorganic carbon (DIC) with 14C activities which were as much as 50% below the initial activities of the soil CO2. The third carbon source, a biogenic CO2, could be detected only indirectly, and its presence was primarily deduced from the occurrence of methane in the deeper parts of these aquifers. The large isotope fractionation which occurred during bacterial co-production of CO2 with this methane resulted, however, in a 13C-rich CO2 and thus a DIC with high delta-13C values. Since the origin of the destroyed organic matter was not known, no assessment of the importance of this CO2 for the 14C contents of the DIC was possible.

78:02F-027
DELAYED AQUIFER YIELD AS A PHENOMENON OF DELAYED AIR ENTRY,
Bouwer, H., and Rice, R.C.
United States Water Conservation Laboratory, Science and Education Administration, United States Department of Agriculture, Phoenix, Arizona 85040.
Water Resources Research, Vol. 14, No. 6, p 1068-1074, December, 1978. 8 fig, 10 ref, 6 equ.

Descriptors: Water table aquifers, Aquifer testing, Vadose water, Air entrainment, Pore water, Drawdown, Specific yield, Pumping, Groundwater, Laboratory tests.

Delayed release of pore water from a pumped, unconfined aquifer is treated as a situation of restricted air movement in the vadose zone due to layers of high water content. This restricted movement produces below-atmospheric pressures in the pore air above the water table, which cause the water table initially to drop faster than the dewatered zone. The initial yield thus is less than the full specific yield, which develops after a certain water table drop. Equations were derived that relate delayed yield to air entry value and height above water table of saturated layers in the vadose zone. These equations agreed with results from a delayed yield experiment on a vertical soil column and produced ratios between initial and final yield that resembled those calculated by others from actual pumping tests. An axisymmetric flow system, simulated by interconnected jars with narrow standpipes, produced delayed yield drawdown curves that were amendable to Boulton's analysis.

78:02F-028
SUBSURFACE DRAINAGE IN SOILS WITH HIGH HYDRAULIC CONDUCTIVITY LAYERS,
Tang, Y.K., and Skaggs, R.W.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Transactions of the American Society of Agricultural Engineers, Vol. 21, No. 3, p 515-521, May-June, 1978. 16 fig, 20 ref.

Descriptors: *Subsurface drains, *Hydraulic conductivity, *Soils, Groundwater movement, Water table aquifers, Drains, Mathematical models, Equations, Head loss, Saturated flow, Computer models.

The Richards equation for two-dimensional, saturated-unsaturated flow during drainage was solved for layered soils using finite difference methods. Solutions were obtained for soils in which the deeper layer has a higher hydraulic conductivity than the surface layer. Solutions were presented to show the distribution of equipotential lines and position of the water table during drainage processes. When the drain depth is increased so that it is closer to the high conductivity layer, head loss due to convergence near the drain is reduced. Thus, deeper drains may significantly increase drainage rates, even if the hydraulic head at the outlet remains unchanged. This effect is larger for deep profiles and narrow drain spacings than for shallow profiles and wide spacings. The effect of increasing the drain depth also increases with the hydraulic conductivity of the bottom layer. When outlet conditions are limiting, the most efficient drain depth is that of the layer interface. Solutions for various cases showed that further increasing the depth had only a slight effect on water table drawdown.

SECTION VII

WATER CYCLE

WATER IN SOILS (GROUP 02G)

78:02G-001
NUMERICAL STUDY OF QUASI-ANALYTIC AND FINITE DIFFERENCE SOLUTIONS OF THE SOIL-WATER TRANSFER EQUATION,
Hayhoe, H.N.
Department of Agriculture, Ottawa, Ontario, Canada.
Soil Science, Vol. 125, No. 2, p 68-74, February, 1978. 3 fig, 3 tab, 9 ref.

Descriptors: *Infiltration, *Soil water movement, *Wetting, *Model studies, Soil water, Moisture content, Mathematical models, Analytical techniques, Equations, Soil science.

The special case of horizontal infiltration of water into a dry soil was utilized to study the problem of using standard finite differencing with an economic grid refinement to locate the wetting front accurately. The procedure used to determine an average value on grid subintervals for the strongly concentration-dependent soil-water diffusivity was identified as being a critical factor in accurately approximating the moisture profile. New averaging techniques were proposed which were shown to locate the steep front with significantly more accuracy. The exact solution was required as a basis for this study. To meet this need, a quasi-analytic technique was introduced and shown to be effective through numerical experiments and comparison with an alternative scheme.

78:02G-002
BOUNDARY CONDITIONS IN MODELING WATER FLOW IN UNSATURATED SOILS,
Zaradny, H.
Polish Academy of Sciences, Gdansk. Institute of Hydraulic Research.
Soil Science, Vol. 125, No. 2, p 75-82, February, 1978. 11 fig, 20 ref.

Descriptors: *Soils, *Model studies, *Soil water movement, *Unsaturated soils, Flow, Mathematical models, Moisture content, Sands, Boundaries (property), Equations.

Simultaneous physical and mathematical modeling was employed to prove that the Richards equation holds true for problems of water flow in unsaturated sand soils. This was shown through good agreement between computation results and data obtained from a physical model. Fine sand was used in the model, and changes in the water content were measured with Am 241. Good results were obtained upon assuming the boundary condition along the supply line to be in the form of the x-derivative of water content. It also was found that the widely accepted boundary condition, namely that water content is constant at the supply boundary, can bring about erroneous conclusions. Good efficiency was achieved in the computations upon the assumption of a time variable increment which can be determined with a criterion derived through numerical experiments.

78:02G-003
THE USE OF DYNAMIC SOIL WATER CHARACTERISTICS IN A NUMERICAL DESORPTION MODEL,
Watson, K.K., and Whisler, F.D.
Mississippi Agricultural and Forestry Experiment Station, Mississippi State.
Soil Science, Vol. 125, No. 2, p 83-91, February, 1978. 6 fig, 11 ref.

Descriptors: *Soil water, *Pressure head, *Soil water movement, *Model studies, Soils, Mathematical models, Water table, Drainage, Desorption, Hysteresis.

A numerical solution of the gravity drainage to a water table of an initially saturated column of porous material was used to examine the results of experimental studies where the volumetric water content (theta) during desorption was found to be dependent on both the soil water pressure head (h) and the rate of change of h with time (dh/dt). In keeping with the experimental findings, the h(theta) relationship was made space-dependent, and the water content and soil water pressure head profiles for this case were compared with the results obtained for two analyses in which the h(theta) relationship was held constant during drainage. These comparisons indicated that the water content profile is generally an insensitive measure of h(theta) variations. The relationship between h and dh/dt for specified theta values was determined from the space-dependent h(theta) analysis and compared with the shape of the curves reported in the experimental studies.

78:02G-004
THEORETICAL MODELING OF MIXED-ELECTROLYTE SOLUTION FLOWS FOR UNSATURATED SOILS,
Bresler, E.
Agricultural Research Organization, Bet Dagan, Israel, Division of Soil Physics.
Soil Science, Vol. 125, No. 4, p 196-203, April, 1978. 20 ref.

Descriptors: *Mathematical models, *Unsaturated flow, *Salts, *Soils, Theoretical analysis, Equations, Calcium, Sodium, Convection, Diffusion.

A mixed salt solution with ions that interact with the soil matrix are important in field problems involving the simultaneous flow of water and mixed Na-Ca salts in unsaturated soils. Governing partial differential equations describing transient, one-dimensional, simultaneous transfer of mixed anions, cations, and water were formulated, taking into account physicochemical interaction between mono and divalent ions and the soil matrix. Effects of convection, diffusion, mechanical dispersion, anion exclusion, cation exchange and adsorption, and coupling phenomena were considered jointly. Soil-interacting and coupling parameters were estimated theoretically from mixed-ion diffuse double-layer theory, taking into account tactoids, capillarity, and hydrodynamic considerations. The coupling-interacting parameters included: osmotic efficiency coefficient, anion exclusion, cation exchange equilibria, soil water retentivity, and unsaturated hydraulic conductivity and their dependence on soil water content and soil solution concentration and composition. A finite difference approach that eliminates numerical dispersion was used to approximate the nonlinear partial differential equations and the boundary conditions appropriate to infiltration, redistribution, drainage, and evaporation of soil water. A brief computational scheme concluded the paper.

78:02G-005
A SOIL COLUMN TENSION LYSIMETER THAT MINIMIZES EXPERIMENTAL EDGE EFFECTS,
Cronan, C.S.
Dartmouth College, Hanover, New Hampshire, Department of Biological Sciences.
Soil Science, Vol. 125, No. 5, p 306-309, May, 1978. 2 fig, 2 tab, 12 ref.

Descriptors: *Lysimeters, *Leachate, *Soil chemistry, *Infiltration, *Percolation, *Tension lysimeter, *Edge effects, Instrumentation, Infiltrometers, Runoff.

A new tension lysimeter, intended for use with isolated, undisturbed soil columns, has been developed. This lysimeter offers the following advantages: it is inexpensive; it minimizes problems associated with experimental edge effects; it is essentially chemically inert; and it permits sampling both saturated and unsaturated flow in soil leaching experiments. Data were presented to illustrate the relatively low variability observed in flow volumes and leachate chemistry between replicate undisturbed soil columns receiving identical treatments.

78:02G-006
SOLUTE TRANSPORT THROUGH SOIL WITH NONUNIFORM WATER CONTENT,
DeSmedt, F., and Wierenga, P.J.

New Mexico State University, University Park, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 1, p 7-10, January-February, 1978. 4 fig, 16 ref.

Descriptors: *Solutes, *Soil water movement, *Moisture content, *Model studies, Mathematical models, Theoretical analysis, Analytical techniques, Equations, Soil water, Leachate.

An approximate analytical solution was presented for steady flow of salt through soil with a nonuniform distribution of the water content. The solution was in good agreement with a numerical computer solution provided by the CSMP simulation language. Both solutions also agreed with the analytical solution for soils with a uniform distribution of the water content. It was shown that effluent curves from soil profiles, with the same average water content and leached at the same steady rate, are basically the same and thus independent of the variation of the water content in such profiles.

78:02G-007
TRANSIENT-AND STEADY-FLOW EXPERIMENTS TESTING THEORY OF WATER FLOW IN SATURATED BENTHONITE,
Smiles, D.E.
Commonwealth Scientific and Industrial Research Organization, Canberra City, Australia, Division of Environmental Mechanics.
Soil Science Society of America Journal, Vol. 42, No. 1, p 11-14, January-February, 1978. 5 fig, 1 tab, 12 ref.

Descriptors: *Soil water movement, *Flow, *Model studies, Mathematical models, Laboratory tests, Stratified flow, Steady flow, Unsteady flow, Darcy's law, Clays.

The theory of water flow in a saturated, swelling clay has been criticized recently. This criticism concerns possible effects on the material characteristics of particle re-orientation during transient flow, as well as suggestions that the flux equation (Darcy's law) may be inappropriate to such systems. This paper examined these problems by comparing data from transient-and steady-flow experiments with bentonite. The data from all experiments are mutually consistent within the experimental error. It was concluded that Darcy's law is valid for this material and that the conductivity/water content, and water content/suction relationships are well defined.

78:02G-008
DISPERSION IN SOIL COLUMNS: EFFECT OF BOUNDARY CONDITIONS AND IRREVERSIBLE REACTIONS,
Parlange, J.-Y., and Starr, J.L.
Connecticut Agricultural Experiment Station, New Haven.
Soil Science Society of America Journal, Vol. 42, No. 1, p 15-18, January-February, 1978. 4 fig, 17 ref.

Descriptors: *Dispersion, *Soils, *Model studies, *Mathematical models, Adsorption, Convection, Diffusion, Soil water, Solutes, Aqueous solutions.

A closed form approximate analytical solution was provided which describes the transport of a solute in a soil column. The effects of convection, dispersion, and adsorption were included. The latter can include both linear adsorption and first-or zero-order reactions. The effect of the finite length of a soil column on the miscible displacement of the solute was discussed in detail. It was shown in particular that the standard solution used in the past is accurate to describe the breakthrough curve but not the profile within the column.

78:02G-009
STEADY-STATE SOLUTE CONVECTION IN TWO DIMENSIONS WITH NONUNIFORM INFILTRATION,
Batu, V., and Gardner, W.R.
Wisconsin University, Madison, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 1, p 18-22, January-February, 1978. 6 fig, 16 ref.

Descriptors: *Solute, *Percolation, *Infiltration, *Model studies, Mathematical models, Soil water, Soil water movement, Flow, Unsaturated flow, Non-uniform flow.

The steady-state unsaturated flow equation in two dimensions was solved for an exponential unsaturated conductivity using the Kirchhoff transformation. Streamlines, travel times, and isochrones were calculated for an infiltration rate which is a piece-wise linear function of horizontal coordinate. Results were compared with the equivalent solutions for a saturated soil. In addition to solutions in dimensionless form, an example was presented for Plainfield sand. The results confirmed that surface variations in infiltration rate may be propagated to a considerable depth, particularly in sandy soils. This may account, in part, for the variability in solute leaching frequently observed in the field.

78:02G-010
EFFECTS OF CLAY TYPE AND CONTENT, EXCHANGEABLE SODIUM PERCENTAGE, AND ELECTROLYTE CONCENTRATION ON CLAY DISPERSION AND SOIL HYDRAULIC CONDUCTIVITY,
Frenkel, H., Goertzen, J.O., and Roades, J.D.
Agricultural Research Service, Riverside, California, Salinity Lab.
Soil Science Society of America Journal, Vol. 42, No. 1, p 32-39, January-February, 1978. 9 fig, 2 tab, 31 ref.

Descriptors: *Hydraulic conductivity, *Electrical conductance, *Soils, *Clays, Laboratory tests, Soil water movement, Soil water, Alkaline soils, Leachate, Salts.

The hydraulic conductivities and gradients along soil columns packed with montmorillonitic, vermiculitic, and kaolinitic soils adjusted to different levels of exchangeable sodium were determined at different salt concentrations. The data showed that plugging of pores by dispersed clay particles is a major cause of reduced soil hydraulic conductivity for surface soils irrigated with sodic waters.

78:02G-011
MULTIPLE TENSIOMETER FLUSHING SYSTEM,
Huber, M.J., and Dirksen, C.
Agricultural Research Service, Riverside, California, Salinity Lab.
Soil Science Society of America Journal, Vol. 42, No. 1, p 168-170, January-February, 1978. 1 fig, 5 ref.

Descriptors: *Tensiometers, *Soil water, *Instrumentation, Equipment, Valves, Air, Bubbles, Irrigation, Soil science, Flushing.

A system for simultaneous flushing of a large number of tensiometers was described. It includes a multiple shutoff valve and a manometer with movable bottom. Flushing procedures were described; they are fast and simple. It can be used with any direction of installation of tensiometers or tubing, for instance, when all tubing is kept below the soil surface to reduce temperature fluctuations. A concentric tubing arrangement reduces air diffusion into the measuring tubing. The system offers potential for improved data quality and reduced need for flushing.

78:02G-012
HYDRODYNAMIC DISPERSION DURING ABSORPTION OF WATER BY SOIL,
Smiles, D.E., Philip, J.R., Knight, J.H., and Elrick, D.E.
Commonwealth Scientific and Industrial Research Organization, Canberra, Australia, Division of Environmental Mechanics.

Descriptors: *Dispersion, *Soil water movement, *Solutes, *Absorption, Laboratory tests, Leaching, Unsteady flow, Unsaturated flow, Soil water, Salts.

An experimental study is reported of hydrodynamic dispersion of low concentration solutions during absorption into horizontal columns of soil with initially uniform moisture and solute contents. The initial soil solutions were of relatively high salt concentration. It was found that both the water and salt concentration profiles preserved similarity in terms of distance divided by the square root of time. This observation implies that the longitudinal dispersion coefficient is insensitive to pore water velocity and may be taken as a function of the volumetric water content only, at least for a given initial (low) moisture content. The formulation which follows is frankly phenomenological. It provides a simple means of predicting dispersion during flow in unsaturated soils which promises to be sufficiently accurate for most purposes.

78:02G-013
PERINENT CRITERIA FOR DESCRIBING THE DISSOLUTION OF GYPSUM BEDS IN FLOWING WATER,
Keisling, T.C., Rao, P.S.C., and Jessup, R.E.
Goergia Coastal Plain Experimental Station, Tifton, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 2, p 234-236, March-April, 1978. 1 fig, 4 ref.

Descriptors: *Gypsum, *Dissolved solids, *Mass transfer, *Dissolution, Model studies, Mathematical models, Solutes, Flow, Dispersion, Erosion.

The equation for convective-dispersive solute transport in porous beds and the continuity equation were used to derive a relationship describing the dissolution of gypsum beds in flowing water. The parameters involved in the derived relationship were: bed length, solution flow velocity, dispersion coefficient, mass transfer rate coefficient, and gypsum fragment size. The proposed relationship was compared with previously published data and shown to be valid. A potential practical field application of the procedure was presented.

78:02G-014
CALIBRATION STABILITY AND RESPONSE TIME FOR SALINITY SENSORS,
Wood, J.D.
Agricultural Research Service, Riverside, California, Salinity Laboratory.
Soil Science Society of America Journal, Vol. 42, No. 2, p 248-250, March-April, 1978. 1 fig, 4 tab, 14 ref.

Descriptors: *Instrumentation, *Salinity, *Saline soils, *Calibrations, Equipment, Laboratory tests, Stability, Electrical conductance, Measurement, Soil science.

Commercially produced salinity sensors removed from field and lysimeter experiments lasting from three to five years were tested for calibration stability relative to the original factory calibration. Significant changes in calibration occurred in up to 14% of the sensors after four and five years of use. Response to a step-change in salinity also was examined for commercial units in a field installation. Calculated response factors were lower than those found in a previous laboratory experiment. However, response was sufficiently rapid to assure accurate readings if changes in salinity occur in time intervals exceeding five days.

78:02G-015
APPROXIMATE ANALYTICAL SOLUTION FOR SOLUTE FLOW DURING INFILTRATION AND REDISTRIBUTION,
De Smedt, F., and Wierenga, P.J.
New Mexico State University, Las Cruces, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 407-411, May-June, 1978. 5 fig, 3 ref, 20 equ.

Descriptors: Analytical techniques, Dispersion, Soil water movement, Solutes, Infiltration, Simulation analysis, Hydrodynamics, Unsaturated flow, Numerical analysis.

An approximate analytical solution is developed to describe solute flow in soil during infiltration and redistribution. For the solution it is assumed that hydrodynamic dispersion is linearly related to the pore water velocity. In order to use the solution it is necessary to estimate the solute penetration depth. Methods of estimating the solute penetration depth are discussed. Solute concentration distributions computed with the approximate analytical solution are compared with those obtained with a numerical model. It is shown that the solution proposed is most useful during the infiltration phase. During the redistribution phase the approximate analytical solution provides a first-order estimate of the solute distribution with time and depth. Computed chloride distributions compare favorably with chloride concentrations observed by Warrick et al. (1971).

78:02G-016
SOIL WATER FLOW MODEL WITH TWO-DIMENSIONAL AUTOMATIC GAMMA RAY ATTENUATION SCANNER,
Dirksen, C., and Huber, M.J.
Science and Education Administration, Riverside, California, Salinity Laboratory.
Water Resources Research, Vol. 14, No. 4, p 611-614, August, 1978. 2 fig, 17 ref.

Descriptors: *Soil water movement, *Moisture content, *Laboratory tests, *Instrumentation, Model studies, Soil water, Gamma rays, Moisture meters, Soil moisture meters, Automation.

Described is a physical laboratory model to study two-dimensional transient water and solute transport in unsaturated soil, including water uptake by roots. It features an automatic two-dimensional gamma ray attenuation scanner for measuring soil water content. Automation is obtained with a simple closed loop control circuit. After a gamma count is transmitted to the teletypewriter, a signal is sent to the hydraulically moved scanner to search for the next grid point. Upon arrival, the scanner sends a signal back to initiate another data acquisition sequence, and so on. In this way, synchronization between counter and scanner is assured independent of counting time, travel time, configuration of grid points, temporary slowdown, etc. It also eliminates dead time between grid points for any recording pattern. Grid points are established by an array of holes that trap the core of a solenoid actuator. The configuration of grid points can be changed easily by opening and closing the desired holes. This mechanical trapping was found to be simpler and more accurate than a potentiometric control. The soil water flow model is constructed in modules. It can be used as one unit of 3.15 by 1.07 by 0.178 m and inclined up to 30 degrees, or it can be subdivided into up to eight compartments, each with its own drainage filter tubes. The front glass walls allow visual observations of soil packing, wetting fronts, root distribution, etc. The back aluminum walls allow installation of instruments, such as tensiometers, salinity sensors, and psychrometers.

78:02G-017
LINEARIZED MOISTURE FLOW WITH LOSS AT THE SOIL SURFACE,
Lomen, D.O., and Warrick, A.W.
Arizona University, Tucson, Department of Soils, Water and Engineering.
Soil Science Society of America Journal, Vol. 42, No. 3, p 396-399, May-June, 1978. 2 fig, 8 ref, 12 equ.

Descriptors: Soil water movement, Unsaturated flow, Evaporation.

The general solution of a linearized moisture flow equation is derived for point and line sources whether buried or on the soil surface. The surface flux is taken to be proportional to the matric flux potential, which is consistent with the physical situation of small evaporative losses for dry soil and larger losses for wet soil. The fraction of water lost at the surface turns out to be identical for point and line sources and for the steady-state case is (m/(2+m)) exponent (-alpha d) where m is the surface flux proportionality constant, d the depth of source, and alpha a constant from the assumed unsaturated hydraulic conductivity function. This fraction is plotted as a function of time for a fixed source depth. Also given are curves depicting the total water loss as a function of source depth. A generalized solution is derived for any type of source located in a horizontal plane.

78:02G-018
HYDRAULIC CONDUCTIVITY OF SOILS: UNIFIED APPROACH TO THE STATISTICAL MODELS,
Mualem, Y., and Dagan, G.
Colorado State University, Fort Collins, Department of Civil Engineering.
Soil Science Society of America Journal, Vol. 42, No. 3, p 392-395, May-June, 1978. 12 ref.

Descriptors: *Hydraulic conductivity, *Soils, *Statistical models, Unsaturated flow, Porous media, Soil moisture, Pore pressure, Equations, Mathematical models, Darcy's law.

Conceptual theory of the hydraulic conductivity of unsaturated porous media was presented. This analysis permits the systematic derivation of the models of E.C. Childs and N. Collis George, M.R.J. Wyllie and G.H.F. Gardner, and Y. Mualem, as well as other existing and new versions, from common statistical principles. The resulting formulas of unsaturated hydraulic conductivity can be classified into three categories: (1) universal formulas independent of the soil type which result from extremely simplifying assumption; (2) formulas with one degree of freedom, and (3) formulas with two degrees of freedom. The latter two types of equations result from accounting for the correlation between pores and the tortuosity of flow path. These formulas can be adjusted to soil type to represent better the variability of soil properties and to increase the accuracy of the predicted hydraulic conductivity. However, in this stage it is a potential advantage only. Empirical study should be followed in order to derive the optimal methods of estimating the unknown parameters.

78:02G-019
LEACHING CHARACTERISTICS OF A LAYERED FIELD SOIL,
Starr, J.L., DeRoo, H.C., Frink, C.R., and Parlange, J.Y.
Connecticut Agricultural Experiment Station, New Haven.
Soil Science Society of America Journal, Vol. 42, No. 3, p 386-391, May-June, 1978. 8 fig, 18 ref.

Descriptors: *Groundwater movement, *Percolating water, *Soil physical properties, Infiltration, Soil chemistry, Leaching, Solutes, Soil water movement, Saturated flow.

Two ponded flow experiments were conducted to study the leaching characteristics of a layered field soil, fine sandy loam over coarse sand, with a water table at a depth of 1.8 m. In the first experiment, a steel cylinder 1.8 m in diameter was driven into a soil to a depth of 3.6 m. Infiltrations of water and dye provided the means for direct observation of the effect of air entrapment upon the rates of infiltration as well as the primary pattern of water flow through the coarse subsoil. The rate of infiltration was observed to increase by nearly twofold when the entrapped air between the saturated surface layer and the shallow groundwater table was vented directly to the atmosphere. Removal of the soil layers following infiltration of a dye solution showed that most of the infiltrating water moved through fingers ranging from 5 to 20 cm in diameter. In the second experiment, chloride distributions at six depths were measured following the application of a pulse of 0.3N CaCl2 solution to the soil surface. Chloride movement for the 20- to 60-cm soil depths averaged about 50% slower than that determined from the average pore-water velocity at the soil surface. In contrast to this relatively low rate of chloride movement, several salt pulses reached the 120- and 180-cm depths soon after or before reaching the 60-cm depth. This greatly increased flow rate corresponds to the observations in the first experiment where flow became unstable and the solute moved in fingers of flow below the 60-cm depth.

78:02G-020
AN ANALYSIS OF SENSIBLE AND LATENT HEAT FLOW IN A PARTIALLY FROZEN UNSATURATED SOIL,
Fuchs, M., Campbell, G.S., and Papendick, R.I.
Washington State University, Pullman, Department of Agronomy and Soils.
Soil Science Society of America Journal, Vol. 42, No. 3, p 379-385, May-June, 1978. 5 fig, 2 tab, 15 ref, 36 equ, 2 append.

Descriptors: Frozen soils, Heat flow, Freezing, Thawing, Solutes, Latent heat, Thermal conductivity.

A heat flow theory has been developed which can be used to predict freezing and thawing cycles of a temperate soil. The latent heat of fusion is incorporated into the classical heat flow equation with the heat capacity and the thermal conductivity of the soil modified to include terms which account for the phase transformation. Computations for a Palouse silt loam soil show that the ice-liquid phase transformation occurs over a defined temperature range where the apparent heat capacity and the apparent thermal conductivity may take on values which are several orders of magnitude larger than those either in the unfrozen or in the near completely frozen soil. The computations also indicate that the presence of solutes in the soil water significantly lowers the temperature range over which the freeze-thaw zone develops and may allow considerable transport of water and heat at lower temperature than in the absence of solutes.

78:02G-021

A METHOD OF PROMOTING PENETRATION OF WATER INTO TIGHT, SLOPING SOIL UNDER DRIP IRRIGATION,

Hillel, D.
University of Massachusetts, Amherst, Department of Plant and Soil Science.
Soil Science, Vol. 125, No. 5, p 329-330, May, 1978. 1 fig.

Descriptors: Irrigation, Infiltration, Penetration, Runoff, Evaporation, Root zone, Gravels, Methodology.

A method is proposed to increase penetration of water into the root zone, as well as to reduce runoff and evaporation by means of gravel-filled pits under each emitter when drip irrigation is applied to sloping ground of low infiltrability. A sample calculation is provided to help determine the optimal dimensions of the gravel pits.

78:02G-022

FRONTAL MOVEMENT OF AQUEOUS SOLUTIONS DURING REDISTRIBUTION THROUGH AIR-DRY SAND COLUMNS AS A FUNCTION OF COLUMN LENGTH AND TIME,

Routson, R.C., and Brown, D.J.
Battelle Pacific Northwest Laboratories, Richland, Washington.
Soil Science, Vol. 125, No. 5, p 320-325, May, 1978. 5 fig, 3 tab, 19 ref.

Descriptors: *Aqueous solutions, *Sands, *Laboratory tests, *Soil water movement, Sorption, Soils, Depth, Graphical analysis, Equations, Wetting.

The frontal movement during redistribution of unsorbed waste fronts through an air-dried sand was measured as a function of time and column length for columns 25-200 cm long. All column data fit an equation of the form S = Ex T to the F power. S was found to be significantly correlated with T (at the 1% level). The equation was normalized by dividing S and E by the column length. When this was done, data for all columns fit a single normalized equation. Use of this equation allows estimation of the shortest possible time necessary for the front of a pulse of waste solution to reach a given depth in a homogeneous soil system.

78:02G-023

EXCHANGEABLE SODIUM AND SOIL WATER BEHAVIOR UNDER FIELD CONDITIONS,

Acharya, C.L., and Abrol, I.P.
Central Soil Salinity Research Institute, Karnal, India.
Soil Science, Vol. 125, No. 5, p 310-319, May, 1978. 9 fig, 1 tab, 15 ref.

Descriptors: *Sodium, *Soil management, *Alkaline soils, *Irrigation water, *Soil chemical properties, Infiltration, Permeability, Soil analysis, Leaching, Land reclamation.

The effect of exchangeable sodium on soil water behavior under field conditions was investigated in five differentially gypsum treated plots of a highly sodic soil. The soil is representative of the sodic soils of the Indo-gangetic plains in northern India. The soil texture is sandy loam in the surface 0-15 cm, and the clay fraction is dominantly illitic. Exchangeable sodium percentage (ESP) varied from 4 to 38 in 0-15 cm, and 28 to 88 in the 15-30 cm layer. Basic intake rate of the soil increased from 8.7 mm per day in soil of highest ESP to about 25 mm per day in soil of lowest ESP. Higher basic intake rate and increased retention at low suctions resulted in greater profile water storage.

Soil water diffusivity values (D) calculated from the water distribution following evaporation showed that at a water content of 0.22 cu cm/cu while D (sq cm/day) decreased from 34 to 26 when ESP increased from 4 to 11, the D value sharply decreased to 8 with a further rise in ESP to 16. Improvement in transmission characteristics resulting from lowered ESP was reflected in the drying pattern of soils. The first stage of drying was delayed in low ESP treatments compared to the high ESP treatment because of regular movement of water from lower layers to the surface to meet the evaporation demand. The effect of treatments on water movement was noticeable to a depth of 90 cm studies in these experiments, although the improvement in layers below 15 cm was very small in treatments receiving lower doses in gypsum.

78:02G-024
COMPACTION EFFECTS ON THE HYDRAULIC CONDUCTIVITY OF A CLAY SOIL,
Douglas, E., and McKyes, E.
Macdonald College, Ste. Anne de Bellevue, Quebec, Canada, Department of Agricultural Engineering.
Soil Science, Vol. 125, No. 5, p 278-282, May, 1978. 6 fig, 7 ref.

Descriptors: *Compaction, *Compacted soils, *Hydraulic conductivity, *Clays, Unsaturated flow, Laboratory tests, Equations, Saturated soils, Porosity, Pressure.

Unsaturated hydraulic conductivities of laboratory-compacted samples of Ste. Rosalie clay were measured, and the values obtained were corrected for the effective changing porosity under increasing pressure gradients. An equation was presented that permits predicting the corrected hydraulic conductivity as a function of compaction in terms of porosity.

78:02G-025
USE OF METHANOL-WATER SOLUTIONS FOR FREEZE PROTECTION OF TENSIOMETERS,
Wendt, C.W., Wilke, O.C., and New, L.L.
Texas A & M University, Lubbock, Agricultural Research and Extension Center.
Agronomy Journal, Vol. 70, No. 5, p 890-891, September-October, 1978. 2 fig, 1 tab.

Descriptors: Frozen soils, Freezing, Tensiometers, Irrigation, Soil water, Soil water movement.

The use of tensiometers to schedule irrigations has been limited primarily to summer crops because of water freezing in the tensiometers during the winter months. Since methanol-water mixtures have lower freezing points than water, a greenhouse study was conducted using an Olton loam soil (Acridic Paleustolls) to determine the effect of a methanol-water mixture (30% methanol by volume) on tensiometer readings and plant growth. No major effects of tensiometer readings or plant growth were noted. Results from a field demonstration on irrigated winter wheat (Triticum aestivum L.) indicate that tensiometers with such mixtures can be used to estimate soil water tension changes at atmospheric temperatures down to -18.8 C.

78:02G-026
EVALUATION OF PEAT AND GRANULAR INOCULUM FOR SOYBEAN YIELD AND N FIXATION UNDER IRRIGATION,
Bezdicek, D.F., Evans, D.W., Abede, B., and Witters, R.E.
Washington State University, Pullman, College of Agriculture Research Center.
Agronomy Journal, Vol. 70, No. 5, p 865-868, September-October, 1978. 1 fig, 5 tab, 15 ref.

Descriptors: Nitrogen fixation, Carriers, Soybeans, Peat, Granules, Symbiosis.

The purpose of this study was to evaluate peat and granular inoculum for effectiveness in nodulation, N fixation, and yield of soybeans in a soil deficient in N. Maximum yield response from inoculation (less control) was 3,454 kg/ha (51.4 bu/A) in 1975 and 2,547 kg/ha (37.9 bu/A) in 1976. Total N fixed was estimated to be as high as 311 and 263 kg/ha in 1975 and 1976, respectively.

The proportion of plant N derived from N fixation ranged from 71 to 80%. Estimates of total N fixed based on acetylene reduction were half of those based on total plant N. In general, higher soybean yield and better nodulation were obtained with the granular than peat carriers, although in these instances, higher-than-recommended rates of granular carriers were used. These studies show that soybeans are capable of fixing over 300 kg/ha of N, an amount which is considerably higher than that reported elsewhere. The data suggest that in soybean-growing areas where 25 to 40% of the total N is from fixation, the soybean symbiotic N-fixing system is capable of fixing sufficient N for yields far beyond that now reported.

78:02G-027

STUDY OF THE RELATIVE EFFICIENCY OF FINITE DIFFERENCE AND GALERKIN TECHNIQUES FOR MODELING SOIL-WATER TRANSFER,

Hayhoe, H.N.
Department of Agriculture, Ottawa, Ontario, Canada, Chemistry and Biology Research Institute.
Water Resources Research, Vol. 14, No. 1, p 97-102, February, 1978. 8 fig, 2 tab, 14 ref.

Descriptors: *Infiltration, *Soil water, *Soil water movement, *Model studies, Mathematical models, Numerical analysis, Analytical technique, Moisture content, Soils, Soil science.

Horizontal infiltration of water into a dry soil was used to study the efficiency of finite difference and Galerkin procedures in accurately locating the steep wetting front. The location of the wetting front was determined by a quasi-analytic solution to Richard's equation. The Galerkin technique was evaluated by using linear, Hermite cubic, and Lagrange quintic elements. These schemes were compared with the performances of the Crank-Nicolson central difference method where a standard and a modified averaging procedure for soil-water diffusivity on grid subintervals is utilized. The comparisons were made on the basis of error as a function of spatial grid refinement and the relative efficiency in achieving a practical level of accuracy. The results lead to the conclusion that the Galerkin scheme with linear elements or the finite differencing scheme with the modified averaging procedure is preferable to the other techniques.

78:02G-028

VARIABILITY OF HYDRAULIC CONDUCTIVITY WITHIN AND BETWEEN NINE WISCONSIN SOIL SERIES,

Baker, F.G.
Wisconsin University, Madison, Department of Soil Science.
Water Resources Research, Vol. 14, No. 1, p 103-108, February, 1978. 3 fig, 2 tab, 17 ref.

Descriptors: *Hydraulic conductivity, *Moisture content, *Variability, *Soil types, *Wisconsin, Soil horizons, Infiltration, Soils, Soil water, Soil water movement.

Hydraulic conductivity was measured in selected subsurface horizons of nine soil series by using the crust test method. Measurements were made for several moisture potentials in the range 0 to -150 cm of water at several randomly selected sites per soil series. The morphological character of the soil series spanned a broad range, from sands to clay loam soils. The hydraulic conductivity characteristic of each series was described mathematically and the series conductivity curves were related as a family of curves. By using multivariate discriminant analysis, the series were grouped into classes of similar hydraulic behavior, based on the dispersion of moisture potential and hydraulic conductivity data within and between series. A 95% prediction interval was constructed to include the range of conductivities to be expected at future sites.

78:02G-029

EFFECT OF SOIL MATRIC POTENTIAL AND SEEDING DEPTH ON EMERGENCE OF BARLEY,

Sepaskhah, A.R., and Ardekani, E.R.

Pahlavi University, Shiraz, Iran, Department of Irrigation.
Agronomy Journal, Vol. 70, No. 5, p 728-731, September-October, 1978. 4 tab, 17 ref, 6 equ.

Descriptors: Barley, Germination, Emerging vegetation stage, Seeds, Moisture tension, Crop production, Crop response.

The effects of soil matric potential and seeding depth on emergence percent and rate of emergence of barley were investigated. Seedling emergence of 'Zarjo' cultivar of barley was measured in a Calcixerillic Xerochrept soil at -0.6 to -30.0 bars soil matric potentials and at 2 to 12 cm seedling depths in the greenhouse. Cultivar response to seedling depth was determined by seedling emergence measurements of 'Torsh', Zargo, and 'Shaneii' cultivars at seeding depths of 2 to 12 cm under the same experimental conditions. Soil matric potential of -30.0 bars reduced the seedling emergence of Zarjo and resulted in the lowest emergence rate. However, soil matric potentials of -0.6 and -1.5 bars also reduced Zarjo emergence at the 12-cm seeding depth. Seedling emergence and emergence rate of Zarjo were lower at the 12 cm seeding depth at all levels of soil matric potentials. The emergence rate was also reduced at the 8-cm seeding depth, but only at -30.0 bars. Seedling emergence of Shaneii was found to be lower than that of the Torsh and Zarjo cultivars. The rates of emergence of the cultivars were not greatly different at the various seeding depths.

78:02G-030
ALTERNATE DRYING AND REWETTING EFFECTS ON CHEMICAL AND PHYSICAL PROPERTIES AND MOISTURE-SALINITY RELATIONSHIPS OF A HISTOSOL,
Giskin, M., and Levin, I.
Agricultural Research Organization, Bet Dagan, Israel, The Volcani Center.
Agronomy Journal, Vol. 70, No. 3, p 445-447, May-June, 1978. 1 fig, 2 tab, 19 ref.

Descriptors: Organic soils, Drying, Wetting, Soil management, Soil chemical properties, Soil physical properties, Moisture content, Electrical conductance, Irrigation.

The purpose of the study was to investigate the possible influences on soil management of changes in chemical and physical properties resulting from a Histosol being carried through several successive dryings and wettings. Soil from the 0 to 30 cm layer of a low moor Histosol with a pH of 7.6 and organic matter content of 55.3% was used. The soil was put through three successive cycles of air-drying and rewetting; subsamples were removed at each stage and physical and chemical determinations were carried out. The saturation percentage of the field sample decreased from 95.9 to 87.3% after the third drying cycle. The electrical conductivity of the saturation extract decreased at each drying stage, due to the large differences in the nitrate content between the dry and wet stages (8 vs. 380 ppm). Moisture retention curve data showed a 5% difference in available water between the moist field sample and the same sample after air-drying. The data showed that laboratory measurements of soil-water relations for a Histosol change with time, i.e., with each exposure to drying and rewetting prior to sampling. This information will have a direct bearing on the management of a Histosol.

78:02G-031
SOIL MOISTURE SENSING WITH AIRCRAFT OBSERVATIONS OF THE DIURNAL RANGE OF SURFACE TEMPERATURE,
Schmugge, T., Blanchard, B., Anderson, A., and Wang, J.
National Aeronautics and Space Administration, Greenbelt, Maryland, Goddard Space Flight Center.
Water Resources Bulletin, Vol. 14, No. 1, p 169-178, February, 1978. 7 fig, 1 tab, 7 ref.

Descriptors: *Remote sensing, *Soil moisture, *Soil temperature, *Arizona, Soil surfaces, Temperature, Diurnal, Crops.

Aircraft observations of the surface temperature were made by measurements of the thermal emission in the 8-14 micrometer band over agricultural fields around Phoenix, Arizona. The diurnal range of these surface temperature measurements was well correlated with the ground measurement of soil moisture in the 0-2 cm layer. The surface temperature observations for vegetated fields were found to be within 1 or 2C of the ambient air temperature, indicating no moisture stress. These results indicated that for clear atmospheric conditions remotely sensed, surface temperatures can be a reliable indicator of soil moisture conditions and crop status.

78:02G-032

NUTRIENT EFFECTIVENESS IN RELATION TO RATES APPLIED FOR POT EXPERIMENTS: I. NITROGEN AND POTASSIUM,

Terman, G.L., and Mortvedt, J.J.
National Fertilizer Development Center, Muscle Shoals, Alabama, Soils and Fertilizer Research Branch.
Soil Science Society of America Journal, Vol. 42, No. 2, p 297-302, March-April, 1978. 7 fig, 7 ref.

Descriptors: Fertilizers, Nutrients, Nitrogen, Potassium, Phosphorus, Rates of application, Greenhouses, Corn (field), Rice, Crop response.

A N source experiment was conducted on infertile Mountview sil (Typic Paleudult) to evaluate four N sources at multiple rates of applied N and P. Granular ammonium nitrate (AN), sulfur-coated urea (SCU), oxamide (Ox), and isobutylidene diurea (IBDU) were evaluated for corn (Zea mays L.) at N rates of 0, 400, 800, and 1,200 mg/pot (5 kg of soil), each at P rates of 0, 60, 120, 480, and 960 mg/pot. Yield response to applied N was in the order AN >> SCU > Ox > IBDU at the higher rates of applied P. At 60 and 120 mg of applied P/pot, however, P was too deficient for satisfactory evaluation of the N sources. In an experiment with flooded rice (Oryza sativa L.), P limited yields less than did N. In other N-P and P-K factorial experiments, rates of other nutrients and length of growth period also greatly affected crop response to applied N and K.

78:02G-033

NUTRIENT EFFECTIVENESS IN RELATION TO RATES APPLIED FOR POT EXPERIMENTS: II. PHOSPHORUS SOURCES,

Mortvedt, J.J., and Terman, G.L.
National Fertilizer Development Center, Muscle Shoals, Alabama, Soils and Fertilizer Research Branch.
Soil Science Society of America Journal, Vol. 42, No. 2, p 302-306, March-April, 1978. 4 fig, 3 tab, 12 ref.

Descriptors: Nutrients, Rates of application, Phosphorus compounds, Fertilizers, Greenhouses, Corn (field), Crop response, Crop production.

Three greenhouse pot experiments were conducted with corn (Zea mays L.) grown on infertile soils to evaluate four fertilizers as sources of P. The granular sources were concentrated superphosphate (CSP, 90% of P water-soluble), monoammonium phosphate (MAP, 100% of P water-soluble), a mixture of 30% of the P as CSP and 70% as dicalcium phosphate (DCP, water-insoluble), and a 10-90% mixture of CSP and DCP. Various rates of P per plot from each source were compared. These P sources and rates were compared at various levels of N and K. The order of effectiveness was the same at all levels of applied N and K: MAP > CSP > 30% CSP + 70% DCP > 10% CSP + 90% DCP. This indicates that on these soils, P was the chief limiting nutrient at all levels of N and K. However, yield levels and the precision of determining differences in effectiveness among sources relative to experimental error increased greatly at higher rates of applied N and K.

78:02G-034

RAPID ESTIMATE OF UNSATURATED HYDRAULIC CONDUCTIVITY FUNCTION,

Bresler, E., Russo, D., and Miller, R.D.
Agricultural Research Organization, Bet Dagan, Israel, Division of Soil Physics.
Soil Science Society of America Journal, Vol. 42, No. 1, p 170-172, January-February, 1978. 4 fig, 10 ref.

Descriptors: *Hydraulic conductivity, *Unsaturated flow, *Infiltration, *Estimating equations, Laboratory tests, Soil physical properties, Pore pressure, Pore water, Horizontal infiltration, Wetting front.

From results of Reichardt, Nielsen, and Biggar and of Russo and Bresler, it was inferred that a laboratory horizontal infiltration experiment with air-dry soil yields an estimate of the saturated-unsaturated hydraulic conductivity function given by K(h) = 0.27(m to the 4th power)(h sub e/h) to the 2.6 power or K(theta) = 0.27(m to the 4th power)(theta - theta sub d)(theta sub w - theta sub d)) to the 7.2 power. Here m = dx/d(t to the 1/2 power); x is distance to the wetting front and t is infiltration time; theta sub d and theta sub w are water contents of air-dry and "unsaturated" soil; h is pore water pressure head, and h sub e is the air entry value of h. These relationships can serve as a general approximation of K(theta) and K(h) in nonsodic stable soils. Field measurements of h sub e and saturated K can also be used to derive K(theta) and K(h).

78:02G-035

THE ROLE OF NITRATE DIFFUSION IN DETERMINING THE ORDER AND RATE OF DENITRIFICATION IN FLOODED SOIL: I. EXPERIMENTAL RESULTS,

Reddy, K.R., Patrick, W.H., Jr., and Phillips, R.E.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Soil Science Society of America Journal, Vol. 42, No. 2, p 268-272, March-April, 1978. 5 fig, 3 tab, 18 ref.

Descriptors: Denitrification, Nitrates, Anaerobic conditions, Flooding, Submergence, Nitrogen, Diffusion, Incubation.

In this study, 15 soils from various locations in the U.S. were amended with 0.5% rice straw and incubated under saturated conditions without O2, either with no excess floodwater or with a 3-cm overlying layer of floodwater. The disappearance of added and native NO3(-)-N and its conversion to N2 and N2O followed apparent zero-order reaction kinetics when all the NO3(-)-N was present in the active soil layer (no excess floodwater). When added NO3(-)-N was present in both the floodwater and the soil layer, NO3(-)-N disappearance followed apparent first-order reaction kinetics. A decrease in NO3(-)-N concentration in the soil layer caused NO3(-)-N in the floodwater to diffuse into the soil layer (a first-order reaction with respect to NO3(-)-N concentration) where it was denitrified. The rate of denitrification was faster in soils incubated with no excess floodwater compared to soils incubated under 3 cm of floodwater. One soil (Crowley silt loam), when incubated with no added carbon source and no excess floodwater, showed NO3(-)-N disappearance to follow first-order kinetics. When this soil was incubated with an additional carbon source, NO3(-)-N disappearance was zero-order.

78:02G-036

THE ROLE OF NITRATE DIFFUSION IN DETERMINING THE ORDER AND RATE OF DENITRIFICATION IN FLOODED SOIL: II. THEORETICAL ANALYSIS AND INTERPRETATION,

Phillips, R.E., Reddy, K.R., and Patrick, W.H., Jr.
Kentucky University, Lexington, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 2, p 272-278, March-April, 1978. 7 fig, 13 ref, 12 equ, 1 append.

Descriptors: Denitrification, Nitrates, Flooding, Submergence, Nitrogen, Diffusion, Theoretical analysis.

A theoretical analysis of denitrification occurring in submerged soil in a test tube, when assumed to be a zero-order reaction with available organic carbon nonlimiting, appears to be a first-order reaction if the effects of diffusion are neglected. This is so because denitrification occurs at a faster rate than the diffusive flux can supply NO3(-)-N to the soil. After some length of time, the concentration of NO3(-)-N in the lower portion of the flood-water-soil interface will be equal to the concentration in the flood-water. After which time, denitrification occurs only in the upper portion of the soil sample. It is suggested that the true order of reaction and rate constant of denitrification in a test tube can be evaluated experimentally by eliminating the floodwater above the soil sample; with this experimental geometry some of the confounding effects of diffusion of NO3(-)-N can be minimized. If diffusion is neglected, not only is the order of reaction misjudged but the depth of floodwater above the soil has a significant effect on the magnitude of the calculated rate constant of the apparent first-order reaction also.

78:02G-037
RELATIONSHIP TO EXTRACTABLE SOIL MANGANESE TO SOIL PROPERTIES,
Shuman, L.M., and Anderson, O.E.
Georgia University, Experiment, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 666-667, July-August, 1978. 2 tab, 8 ref.

Descriptors: Manganese, Soil chemical properties, Soil physical properties, Ammonium compounds, Organic matter, Cation exchange, Greenhouses, Soil chemistry.

In a greenhouse experiment eight Southeastern soils were amended to give pH levels of 4.8, 5.8, and 6.8 and were treated with 0, 25, and 50 ppm Mn. After growing wheat (Triticum aestivium L.) for 40 days, the soils were extracted for Mn using six extractants: H20, neutral 1N NH40Ac (with and without 0.2% hydroquinone), "double acid", diethylenetriaminepentaacetic acid (DTPA) and ethylenediaminedi-o-hydroxyphenylacetic acid (EDDHA). Except for the low-Mn soils, greater differences in extractable Mn were observed among soil types and soil pH levels than among Mn rates. Extractable Mn was correlated with soil clay content and total soil Mn. Organic matter content with a narrow range from 1.0 to 2.9%, silt content and cation exchange capacity (CEC) were not correlated with extractable Mn. The extractable Mn decreased as soil pH increased for the H20, NH40Ac alone, and DTPA extractants making them preferable for predicting soil Mn availability since higher pH causes Mn to be less available to the plant.

78:02G-038
A SOIL MOISTURE BUDGET MODEL ACCOUNTING FOR SHALLOW WATER TABLE INFLUENCES,
Stuff, R.G., and Dale, R.F.
Purdue University, West Lafayette, Indiana, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 637-643, July-August, 1978. 9 fig, 1 tab, 15 ref, 10 equ.

Descriptors: Soil moisture, Evapotranspiration, Capillary water, Water balance, Field capacity, Moisture deficit, Computer models, Water table.

Soil moisture balance programs developed on well-drained soils were found to be unsatisfactory for a soil underlain by shallow water tables, a condition typical of about 9 million acres of cropland in Indiana. Capillary rise past a 105-cm root zone boundary was estimated as the difference between estimated evapotranspiration (ET) and changes in soil moisture under corn (Zea mays L.) on a tile-drained Typic Argiaquoll at West Lafayette, Indiana, during three growing seasons, 1971-1973. Capillary water was found to supply an average of 27% of the ET in periods with little or no precipitation. Computer model estimates showed capillary water to furnish about 17% of the total ET over a 100-day period from 49 days before silking to 50 days after. The derived relationships with those obtained from literature sources and assumptions regarding runoff and recharge were programmed in a computer model for simulating the daily moisture conditions. The model was found to closely track measurements of both soil moisture and water table depths in four independent seasons: early and late plantings in 1970 and 1974.

78:02G-039
SALT OUTFLOWS FROM NEW AND OLD IRRIGATED LANDS,
Carter, D.L., and Robbins, C.W.
Idaho University, Kimberly, Snake River Conservation Research Center.
Soil Science Society of America Journal, Vol. 42, No. 4, p 627-632, July-August, 1978. 3 fig, 3 tab, 13 ref.

Descriptors: Salinity, Leaching, Leachate, Drainage water, Water quality, Salt balance, Irrigated land.

Three water application treatments with low salt water were applied to previously nonirrigated soil and to a similar soil which had been irrigated for 67 years. The total soluble salt content of these soils initially, and after one and two seasons of treatment, was measured to determine salt outflow. Residual soluble salts were essentially removed from the previously nonirrigated soil after 30 cm of water/m depth of soil had passed from the soil as leachate, regardless of the number of seasons required for that amount of leaching. The total quantity of residual salt removed from soil 5 m deep was 70 metric tons/ha, with about 38 metric tons/ha being leached out by the first 14 cm of leachate. After the residual salt was removed, the salt content of the newly irrigated soil was the same as that of the soil which had been irrigated for 67 years. Subsequent salt outflow from the soil was directly related to the quantity of water leaching through the soil, indicating that more minerals dissolved with more leaching. Soils irrigated for many years and then not irrigated for up to 10 years had no measurable reaccumulation of soluble salts during the period of nonirrigation.

78:02G-040
EFFECTS OF SOIL MOISTURE ON THE DIFFUSION COEFFICIENTS AND ACTIVATION ENERGIES OF TRITIATED WATER, CHLORIDE, AND METRIBUZIN,
Scott, H.D., and Paetzold, R.F.
Arkansas University, Fayetteville, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 1, p 23-27, January-February, 1978. 3 fig, 2 tab, 25 ref.

Descriptors: *Diffusion, *Soil moisture, *Solutes, Laboratory tests, Moisture content, Soils, Soil horizons, Adsorption, Radioisotopes, Tritium.

Diffusion coefficients of tritiated water, chloride, and metribuzin were determined in Captina silt loam as functions of soil water content and soil temperature. Tritiated water and metribuzin were found to diffuse in both liquid and vapor phases, whereas chloride diffusion was restricted to the solution phase. For a given soil water content, values of the diffusion coefficients were larger in soil samples from the Ap horizon than in those from the B2t horizon for tritiated water and chloride. This was attributed to the greater tortuosity in the B2t horizon. Metribuzin had similar diffusion coefficients in both horizons, apparently reflecting offsetting effects due to the greater adsorption by the Ap and greater tortuosity in the B2t. Thermodynamic studies indicated that the energy requirement for diffusion of these solutes was inversely related to soil moisture content for tritiated water and metribuzin. Activation energies for chloride diffusion were lower than for other solutes at equal soil water contents.

78:02G-041
LINEAR AND NONLINEAR MODELS OF INFILTRATION FROM A POINT SOURCE,
Ben-Asher, J., Lomen, D.O., and Warrick, A.W.
Arizona Water Resources Research Center, Tucson.
Soil Science Society of America Journal, Vol. 42, No. 1, p 3-6, January-February, 1978. 6 fig, 11 ref.

Descriptors: *Infiltration, *Irrigation, *Soil water movement, *Model studies, Mathematical models, Analytical techniques, Equations, Soils, Soil water, Soil types.

Numerical and analytical solutions for water flow from a point source were compared. The numerical solution was for the nonlinear moisture flow equation, and the analytical solution was for the corresponding linearized form. For cyclic conditions, results were approximately the same with regard to range in values between the wettest and driest values. However, the numerical results showed a faster response both for wetting and drying. Computational times required of the analytical solution were of the order of 1/20 to 1/200th of that required for the finite difference solutions.

78:02G-042
HYDRAULIC CONDUCTIVITY OF UNSATURATED POROUS MEDIA: GENERALIZED MACROSCOPIC APPROACH,
Mualem, Y.

Colorado State University, Fort Collins, Engineering Research Center.
Water Resources Research, Vol. 14, No. 2, p 325-334, April, 1978. 2 fig, 5 tab, 41 ref.

Descriptors: *Hydraulic conductivity, *Porous media, *Unsaturated flow, *Mathematical models, Equations, Theoretical analysis, Soil texture, Statistical models, Porosity, Specific yield.

The macroscopic approach which yields the power function relationship between the relative permeability and the effective saturation, K sub r = S sub e to the n power, was generalized to allow n to vary with the soil type. Theoretical analysis shows that n may receive values lower than 3.0 for granular porous media and higher than 3.0 for soils of the fine texture. These findings were verified by using experimental data of 50 soils. The lower limit of n was found to be 2.5, while high values (up to n = 24.5) were found for the fine-textured soils. Statistical analysis of the measured data of the 50 soil samples showed a significant correlation between n and w, which indicates the amount of work per unit volume of soil required to drain a saturated soil to the wilting point. By using the soil characteristics psi-theta, an empirical formula was derived which relates n to w by n = 0.015w + 3.0. This proposed model was compared with the two previous versions of Averjanov and Irmay on the basis of the experimental data of the 50 soils. A very good agreement was found between the measured K sub r - theta curves and the theoretical ones, derived by the new model, for granular soils as well as for soils of fine texture where the other models very often fail. The accuracy of the new model is competitive with the best of the statistical models analyzed by Mualem. By this study, the power function model gains a high degree of accuracy, which compounded by its simplicity, produces an efficient tool for prediction of the hydraulic conductivity of unsaturated soils.

78:02G-043
SOLUTE TRANSPORT DURING ABSORPTION OF WATER BY SOIL: LABORATORY STUDIES AND THEIR PRACTICAL IMPLICATIONS,
Smiles, D.E., and Philip, J.R.
Commonwealth Scientific and Industrial Research Organization, Canberra City, A.C.T. 2601, Australia, Division of Environmental Mechanics.
Soil Science Society of America Journal, Vol. 42, No. 4, p 537-544, July-August, 1978. 4 fig, 1 tab, 14 ref, 21 equ.

Descriptors: Leaching, Unsaturated flow, Absorption, Scaling, Infiltration, Capillary action.

An experimental study of solute transport during absorption into uniform horizontal soil columns is reported. The inferred dispersion coefficient is essentially independent also of the volumetric moisture content (at least in the range 0.18-0.28). It is approximately equal to the product of the volumetric moisture content and the molecular diffusivity of KCl in water. The practical implications of the work for field problems are explored, use being made of scaling theory for flow processes involving capillarity and viscous flow. It is concluded that, for the majority of field soils, solute transport during unsaturated flow of any practical duration may be described by a velocity-independent dispersion coefficient. This represents a very great simplification of the formulation, analysis, and prediction of solute transport in such systems. The observed pistonlike displacement of the initial water in the columns by the absorbed water suggests that there is no basis for subdividing the water in the system into mobile and immobile fractions. Further theoretical and experimental work is under way on solute transport during infiltration, and during absorption into very coarse-textured soils (for which the dispersion coefficient is not velocity independent.)

78:02G-044
STEADY INFILTRATION FROM SINGLE AND PERIODIC STRIP SOURCES,
Batu, V.
Karadeniz Technical University, Trabson, Turkey, Department of Civil Engineering.
Soil Science Society of America Journal, Vol. 42, No. 4, p 544-549, July-August, 1978. 7 fig, 15 ref, 49 equ.

Descriptors: Infiltration, Soil water, Fourier analysis, Hydraulic conductivity, Sprinkler irrigation.

The matric flux potential and horizontal and vertical flux distributions were obtained using Fourier analysis techniques for single and periodic strip sources located on the soil surface. The theory is based on the assumption that the hydraulic conductivity is an exponential function of the soil water potential. The matric flux potential distributions were compared with the results obtained by Warrick and Lomen (1976, Soil Sci. Soc. Am. J. 40:639-643) who used different mathematical techniques.

78:02G-045

TRANSIENT CHANGES IN THE SOIL-WATER SYSTEM FROM IRRIGATION WITH SALINE WATER: I. THEORY,

Jury, W.A., Frenkel, H., and Stolzy, L.H.
California University, Riverside, Department of Soil and Environmental Science.
Soil Science Society of America Journal, Vol. 42, No. 4, p 579-585, July-August, 1978. 5 fig, 5 tab, 15 ref, 11 equ.

Descriptors: Saline water, Soil water movement, Chemical precipitation, Leaching, Diffusion, Travel time, Cation exchange, Dispersion, Irrigation water.

Transient soil solution concentrations and salt precipitation rates in the root zone are shown to be influenced by the ion composition and concentration of the applied water and soil exchange complex as well as by the water uptake distribution and infiltration rate. Calculations are performed on three kinds of infiltration water to estimate the ionic composition of the soil solution, the rate of gypsum and CaCO3 precipitation, and the time to reach steady state for a given irrigation management. Solution concentrations adjusted for exchange interactions were shown to precipitate twice the quantity of salt in a given time, resulting in lowered solution concentration and altered composition Ca(2+), Mg(2+), Na(2+), and S04(2-) ion concentrations in the solution phase, with up to 1,600 days required to reach steady state through the top 150 cm for a leaching fraction of 0.05. The extent of precipitation is also found to depend strongly on the concentration of sulfate and degree of saturation with gypsum in the irrigation water. Diffusion and dispersion are also shown to influence the duration of the transient phase.

78:02G-046

TRANSIENT CHANGES IN THE SOIL-WATER SYSTEM FROM IRRIGATION WITH SALINE WATER: II. ANALYSIS OF EXPERIMENTAL DATA,

Jury, W.A., Frenkel, H., Devitt, D., and Stolzy, L.H.
California University, Riverside, Department of Soil and Environmental Science.
Soil Science Society of America Journal, Vol. 42, No. 4, p 585-590, July-August, 1978. 4 fig, 7 tab, 13 ref, 3 equ.

Descriptors: Saline water, Soil water movement, Cation exchange, Chemical precipitation, Solutes, Irrigation water, Wheat, Sorghum, Lysimeters.

Twenty-three lysimeters containing four soil types with alternate wheat (Triticum aestivum L.) and sorghum (Sorghum vulgare Pers.) crops were irrigated with three synthesized levels (2.2, 3.9, 7.1 mmho/cm) of irrigation water. Salt balance was calculated from soil salinity sensor electrical conductivity EC measurements by determining a relationship between solution EC and solution concentration using a chemical equilibrium model. Exchangeable cations were measured after the third crop. All methods of determining salt balance showed the order of 50% salt precipitation over the first 500 days of the experiment, approximately two times the expected amount when root zone salt concentrations have reached steady state. Release of Ca(2+) ions from exchange sites and subsequent enhanced gypsum and Ca CO3 precipitation was assumed to be responsible for the difference between transient and steady-state behavior. The drainage composition of a lysimeter which had moved one pore volume through the root zone showed that only Cl(-) was approaching a steady-state value. Exchange effects and enhanced precipitation were assumed to be buffering the concentration of the other ions. Water uptake in all lysimeters was occurring primarily in the top 20 cm, a consequence of high irrigation water salinity and daily irrigation.

78:02G-047
MOISTURE PROFILES DURING STEADY VERTICAL FLOWS IN SWELLING SOILS,
Giraldez, J.V., and Sposito, G.
California University, Riverside, Department of Soil and Environmental Sciences.
Water Resources Research, Vol. 14, No. 2, p 314-318, April, 1978. 3 fig, 1 tab, 21 ref, 10 equ.

Descriptors: Steady flows, Soil water movement, Saturated flow, Unsaturated flow, Profiles, Overburden.

Practical working equations for describing numerically soil moisture profiles in homogeneous swelling soils during steady vertical flows were developed. These equations were solved on a computer with soil water and swelling curve data appropriate to Rideau clay loam, which was taken as a typical example of a swelling soil. Unsaturated swelling soils were shown to exhibit either xeric or hydric profiles for downward flows, whereas for upward flows they exhibit only a zeric profile, just as rigid soils do. On the other hand, saturated swelling soils were shown to have hydric profiles in the downward flow situation and either hydric or zeric profiles during upward flows. The overburden or "envelope pressure" potential was shown to exert a great influence, in almost all circumstances, in reducing the maximum evaporative flow from a shallow water table in a swelling soil as compared to the equivalent nonswelling case.

78:02G-048
A TWO-DIMENSIONAL LINEARIZED VIEW OF ONE-DIMENSIONAL UNSATURATED-SATURATED FLOW,
Cushman, J., and Kirkham, D.
Iowa State University, Ames, Department of Agronomy.
Water Resources Research, Vol. 14, No. 2, p 319-323, April, 1978. 4 fig, 16 ref.

Descriptors: *Saturated flow, *Unsaturated flow, *Mathematical models, *Numerical analysis, Equations, Finite element analysis, Infiltration, Moisture content, Pressure head, Theoretical analysis.

A numerical analysis of the one-dimensional, unsaturated-saturated flow problem was presented. Both the pressure head and moisture content equations were studied for vertical and horizontal infiltration, respectively. The problems were considered in a two-dimensional setting in which time was considered the second dimension. The numerical scheme used was finite element analysis coupled with a simple linearizing assumption. The numerical process was compared with various other analytic and numerical solutions of the same problems. It was shown that if the size of the elements is not too large, the method is very accurate.

78:02G-049
ON OSCILLATION OF NUMERICAL SOLUTION OF A MODIFIED RICHARDS' EQUATION,
Krishnamurthi, N., Sunada, D.K., and Longenbaugh, R.A.
Utah International Incorporated, San Francisco, California, Department of Environmental Quality.
Water Resources Research, Vol. 14, No. 1, p 52-54, February, 1978. 1 fig, 16 ref, 8 equ.

Descriptors: Mathematical studies, Numerical analysis, Soil water movement, Hydraulic conductivity, Gravitational water, Diffusivity.

Numerical solutions of differential equations should be checked for the conditions of consistency, convergence, and stability. The implicit solutions that satisfy these conditions are sometimes found to be oscillatory about the true solutions. The reasons for these oscillations are explained. A method to derive criteria for nonoscillatory solutions of a nonlinear partial differential equation is outlined. These criteria for modified Richards' equation are presented, and their physical significances are explained.

78:02G-050
DENITRIFICATION IN FOUR CALIFORNIA SOILS: EFFECT OF SOIL PROFILE CHARACTERISTICS,

Gilliam, J.W., Dasberg, S., Lund, L.J., and Focht, D.D.
California University, Riverside, Department of Soil Science and Agricultural Engineering.
Soil Science Society of America Journal, Vol. 42, No. 1, p 61-66, January-February, 1978. 4 fig, 3 tab, 25 ref.

Descriptors: Denitrification, Soil profiles, Steady flow, Soil water movement, Nitrates, California.

The effects of soil profile characteristics upon rate and products of denitrification were investigated using four soils in laboratory columns under steady-state water flow conditions. Soils with heavy textured subsoils readily reduced added NO3(-). However, the soil with the lowest clay content had restricted water flow in the surface horizon and reduced the greatest amount of NO3(-). It was concluded that any soil condition which impedes water flow will be positively related to denitrification and that spatial variability in denitrification is likely to be as great as observed variability in water movement. The ratio of N2 to N2O found during denitrification was extremely variable with measured values from 100:1 to 1:4. The low concentrations of N2O measured during denitrification occurred in soils where the denitrification was occurring deep in the soil profile, but there was no indication that this low concentration was a result of further reduction of N2O as N2O diffused through the soil profile. Our data indicate that it is currently not possible to accurately predict relative amounts of N2 and N2O which will be produced during most denitrification in soils, and that estimates of that N2O produced from agricultural lands have a large uncertainty factor.

78:02G-051
RESIDUAL FERTILIZER NITROGEN IN A FLOODED RICE SOIL,
Reddy, K.R., and Patrick, W.H., Jr.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Soil Science Society of America Journal, Vol. 42, No. 2, p 316-318, March-April, 1978. 2 fig, 4 tab, 2 ref.

Descriptors: Nitrogen, Stable isotopes, Fertilization, Rice, Flood irrigation, Incubation, Nutrients.

Residual effects of 15N-labelled fertilizer (ammonium sulfate) nitrogen were measured during the second cropping season of rice (Oryza sativa L.). During the first cropping season, labelled fertilizer N was applied at 100 kg N/ha using different methods of N application. At the end of harvest the rice straw obtained during the first cropping season was incorporated back into the respective plots. During the second season half the plots were treated with an additional 100 kg N/ha of nonlabelled fertilizer N as an early season top dressing. The uptake of residual labelled N was measured during the growing season and at harvest time under fertilized and nonfertilized conditions. The recovery of residual labelled N in grain and straw was 2.7 to 3.1 kg N/ha, with a large fraction of N still remaining in the soil. Approximately 3 to 5 kg of the residual labelled N/ha present at the beginning of the season was not accounted for in any fraction and was assumed to be lost from the system. Over a 2-year period, about 66 to 82% of the applied labelled fertilizer N could be accounted for by plant uptake or in the soil with the remainder lost from the plant-soil system.

78:02G-052
INFILTRATION DURING AN UNSTEADY RAIN,
Chu, S.T.
South Dakota State University, Brookings, Department of Agricultural Engineering.
Water Resources Research, Vol. 14, No. 3, p 461-466, June, 1978. 1 fig, 3 tab, 12 ref.

Descriptors: *Infiltration, *Rainfall, *Model studies, Mathematical models, Precipitation (atmospheric), Soil water, Soil water movement, Rainfall intensity, Precipitation excess, Ponding, Soil moisture, Runoff, Unsteady rain.

Infiltration during a rainfall event can be divided into two distinct stages: a stage with surface ponding and a stage without surface ponding. Few of the infiltration models in current use are suitable to describe infiltration for both stages. In this paper the Green and Ampt equation was applied to determine the time that separates these two stages so that infiltration for the different stages can be treated separately. To obtain an integrated form of the Green and Ampt equation, it is traditionally assumed that the cumulative infiltration is zero at the time when surface ponding starts. But in a rainfall event, the cumulative infiltration equals the water infiltrated into the soil profile prior to the ponding time, which is usually not zero. Therefore, a modification in the traditional Green and Ampt equation is needed to describe infiltration during a rainfall event. It was shown that this modification is equivalent to a shift of the time scale by an amount which was referred to as the pseudotime. The modified version of the Green and Ampt equation was applied to determine rainfall excess and to predict total runoff for three major storms recorded by the Agricultural Research Service from 1957 to 1959 on a watershed near Oxford, Mississippi. A comparison of the prediction and the measured total runoff appeared to be promising.

78:02G-053
THE STATISTICAL MECHANICAL THEORY OF WATER TRANSPORT THROUGH UNSATURATED SOIL 1. THE CONSERVATION LAWS,
Sposito, G.
California University, Riverside, Department of Soil and Environmental Sciences.
Water Resources Research, Vol. 14, No. 3, p 474-478, June, 1978. 26 ref, 30 equ.

Descriptors: Soil water movement, Unsaturated flow, Momentum equation, Fluid mechanics, Continuity equation, Heterogeneity, Soil physics.

The macroscopic differential equations of mass and momentum balance for water in a rigid unsaturated soil are derived from first principles by using the methods of statistical mechanics. The derivation begins with the development, at the molecular level, of expressions for the mass and linear momentum densities of water in a soil. The derivatives of these expressions with respect to the time then provide for local balance equations that are ensemble averaged and local volume averaged in order to produce the macroscopic balance equations. The resulting macroscopic equations agree with those derived for mass and linear momentum transport in a soil on the basis of the continuum theory of mixtures. The unified insight into mass transport processes afforded by a statistical mechanical theory as compared to one evolved from a solely macroscopic view is discussed.

78:02G-054
THE STATISTICAL MECHANICAL THEORY OF WATER TRANSPORT THROUGH UNSATURATED SOIL 2. DERIVATION OF THE BUCKINGHAM-DARCY FLUX LAW,
Sposito, G.
California University, Riverside, Department of Soil and Environmental Sciences.
Water Resources Research, Vol. 14, No. 3, p 479-484, June, 1978. 18 ref, 55 equ.

Descriptors: Soil water movement, Unsaturated flow, Soil water, Hydraulic conductivity, Steady flow, Model studies, Markov processes, Soil physics.

The Buckingham-Darcy flux law, an empirical equation that relates the volumetric flux density of water in an unsaturated soil to the gradient of the total potential, is derived from first principles by using the methods of statistical mechanics. The derivation given, a direct application of well-known techniques in nonequilibrium statistical mechanics, proceeds through a detailed molecular description of two laboratory experiments for measuring the hydraulic conductivity tensor of a homogeneous unsaturated soil. In the first experiment the steady flow of water is induced by a gradient in the matric potential, while in the second, flow is induced by a gradient in the gravitational potential. In both cases, the appropriate form of the Buckingham-Darcy law is derived on the basis of a linear response approximation, and an expression for the hydraulic conductivity is given in terms of a time integral of the correlation function for the velocities of the water molecules in the soil. The problem of calculating the hydraulic conductivity of a soil thereby is reduced to quadrature and to the task of developing a molecular model of the velocity correlations among the water molecules. A recent successful model of this type is discussed briefly.

78:02G-055
A PARAMETER-EFFICIENT HYDROLOGIC INFILTRATION MODEL,
Smith, R.E., and Parlange, J.Y.
Agricultural Research Service, Fort Collins, Colorado.

Water Resources Research, Vol. 14, No. 3, p 533-538, June, 1978. 6 fig, 18 ref.

Descriptors: *Infiltration, *Ponding, *Model studies, Mathematical models, Rainfall, Hydraulic conductivity, Soil water, Soil water movement, Soils, Soil types, Equations, Infiltration rates, Hydrology, Infiltration models.

By adopting two extreme assumptions concerning the behavior of unsaturated soil hydraulic conductivity K near saturation, a two-branched model was derived for ponding time and infiltration rate decay for arbitrary rainfall rates. One assumption was that K varies slowly near saturation and leads to an expression for ponding time and infiltration decay. For initially ponded conditions, ponding time was zero, and with the rainfall rate approaching infinity, the familiar Green and Ampt expression results. The other, rather opposite assumption was that K varies rapidly, e.g., exponentially, near saturation. This model also holds for both rainfall and ponded surface conditions, and for ponded conditions the expression is identical to that of Parlange. Each model uses only two parameters, saturated soil conductivity K sub s and a parameter that is roughly related to sorptivity and responds nearly linearly to variations in initial saturation. Both parameters are physically related to measurable soil properties. Methods were presented to estimate parameters of either model from infiltrometer tests. The two models were compared with a precise numerical solution of the unsaturated soil water diffusion equations for three soils that represent a range of soil behaviors near saturation. Results showed that either assumption would be an excellent model for most hydrologic purposes, and the relative goodness of fit of each model is generally consistent with the appropriate behavior of K, as the water content approaches the saturated water content.

78:02G-056
BASIC MATHEMATICAL MODELS OF TOXICANT TRANSPORT THROUGH THE SOIL PROFILE,
Rachinskii, V.V.
Timiryazev' Academy of Agricultural Sciences, Moscow, Union of Soviet Socialist Republics.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 201-209. 5 ref, 26 equ.

Descriptors: Pesticide kinetics, Sorption, Dynamics, Mathematical models, Chromatography, Kinetics, Pesticide toxicity.

This paper discusses basic mathematical models of toxicant transport through the soil profile; and has developed mathematical expressions for the sorption dynamics problems using the kinetic parameter of time lag and at a variable velocity of the mobile phase.

78:02G-057
DRAINAGE IN A NATURAL LAYERED PROFILE BY FINITE ELEMENT ANALYSIS,
Khanjani, M.J., and Bloomsburg, G.L.
Idaho University, Moscow, Department of Agricultural Engineering.
Paper No. 78-2036, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p. 8 fig, 1 tab, 5 ref.

Descriptors: Drainage, Finite element analysis, Computer programs, Subsurface drains, Water table, Porosity, Hydraulic conductivity, Soil properties, Soil profiles, Pore pressure.

An agricultural soil profile consisting of four different soil types is modeled by means of a finite element computer program. The results are in the form of a curve for water table height at midpoint between drains versus a dimensionless function of time. Composite values for soil properties (apparent, conductivity, displacement head, and drainage porosity) are calculated, and the result from running a one layer composite profile are compared to results from an actual profile. The effect of drain distance above the impermeable layer is also investigated. The Dupuit-Forchheimer assumptions are not used in this analysis and unsaturated flow above the water table is considered.

78:02G-058
INFLUENCE OF SOIL AIR AND DRAINAGE ON INFILTRATION,
Jarrett, A.R., Hoover, J.R., and Davis, C.L.
Pennsylvania State University, University Park, Department of Agricultural Engineering.
Paper No. 78-2039, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 8 p. 7 fig, 22 ref.

Descriptors: Infiltration, Infiltration rates, Drainage, Air, Subsurface drainage, Rainfall, Runoff, Subsurface drains, Surface runoff, Laboratory tests.

The effect of soil air entrapment and subsurface drainage in a sand were evaluated. During rainfall, the entrapped soil air pressure stopped the infiltration process converting all precipitation to runoff except when the entrapped air was permitted to vent via the subsurface drain, at which time infiltration and subsurface drainage started and runoff ceased.

78:02G-059
A SIMPLE FINITE ELEMENT METHOD OF INFILTRATION,
Pall, R., Jarrett, A.R., and Morrow, C.T.
Pennsylvania State University, University Park, Department of Agricultural Engineering.
Paper No. 78-2068, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 10 p. 14 fig, 12 ref, 8 equ.

Descriptors: Infiltration, Infiltration rates, Soil water movement, Numerical analysis, Finite element analysis, Darcy's law, Diffusivity, Computer models, Energy conservation, Soil water.

A numerical solution of one dimensional infiltration was developed from basic principles of flow and energy conservation using finite element technique. An exponential relationship between hydraulic diffusivity and volumetric moisture content was used for diffusivity calculations. Solutions obtained for horizontal moisture distribution gave an excellent agreement with exact solution of Scott et al. and numerical solutions of Philip and Hanks and Bowers.

78;02G-060
PREDICTING DISPERSION COEFFICIENTS IN SOILS,
Smajstrla, A.G., Reddell, D.L., and Barnes, P.L.
Texas A & M University, College Station, Department of Agricultural Engineering.
Paper No. 78-2074, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 16 p. 16 fig, 18 ref, 10 equ.

Descriptors: Dispersion, Soil physical properties, Numerical analysis, Hydrologic properties, Soil water movement, Capillary water, Diffusion, Simulation analysis, Model studies, Computer models.

A numerical model was developed to predict the magnitudes of dispersion coefficients as functions of soil physical and hydrologic properties and solution velocities. A capillary bundle model was used, and the bundle hydraulic properties were determined from the hydraulic conductivity function. Interaction between bundles was described as a diffusion-controlled process. The model generated breakthrough curves from simulated steady flow displacement of one soil solution with a second one. From the breakthrough curves, dispersion coefficients were calculated. The breakthrough curves and dispersion coefficients were compared with those measured in the laboratory with good agreement for unsaturated flow conditions and for saturated flow at low velocities. Agreement during saturated flow at large velocities was only obtained when a matching factor was used to describe mixing between capillary bundles.

78:02G-061
TRANSIENT FLOW IN UNSATURATED POROUS MEDIA,
Lin, S.H.
Polytechnic Institute of New York, Brooklyn, Department of Chemical Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY7, Proceedings Paper 13886, p 975-982, July, 1978. 4 fig, 12 ref.

Descriptors: *Porous media, *Unsaturated flow, *Diffusion, Hydraulic conductivity, Infiltration, Moisture content, Unsteady flow, Silts, Loam, Soil water movement, Mathematical models, Equations, Orthogonality.

Transient water movement in both horizontal and vertical unsaturated porous media was investigated. The nonlinear partial differential equation governing the one-dimensional flow was solved by the orthogonal collocation method. This method involves the approximation of the spatial derivative terms in the partial differential equation by an orthogonal polynomial and thus the partial differential equation is transformed into a set of ordinary differential equations which in turn can be integrated numerically. The present numerical solutions were found to be in excellent agreement with previous solutions for the cases under consideration. Because of its high accuracy, computational stability, and easy implementation, the orthogonal collocation method can be a very good alternative for tackling these nonlinear diffusion problems.

78:02G-062
LONGITUDINAL AND TRANSVERSE DISPERSION COEFFICIENTS IN UNSATURATED PLAINFIELD SAND,
Yule, D.F., and Gardner, W.R.
Wisconsin University, Madison, Department of Soil Science.
Water Resources Research, Vol. 14, No. 4, p 582-588, August, 1978. 7 fig, 2 tab, 19 ref.

Descriptors: *Dispersion, *Soils, *Sands, *Laboratory tests, Instrumentation, Mathematical models, Soil water movement, Unsaturated flow, Transverse dispersion, Longitudinal dispersion.

The relationship between the longitudinal and transverse dispersion coefficients (D sub L and D sub T) and the pore water velocity (v) and the effective diffusion coefficient (D sub e) was determined for v between 0.01 and 0.28 cm/min in a vertical unsaturated column (L = 23 cm) of C horizon Plainfield sand. The inflow and outflow control systems on the soil column consisted of rows of porous ceramic tubes with individual adjustable pressure controls. Uniform inflow and outflow were achieved across the column, and v was maintained constant during each experiment. An analysis of the transverse spread produced indicated that the effect of apparatus-induced dispersion was less than 10%. D sub L (sq cm/min) was linearly related to v(cm/min) (D sub L = 0.216v + 0.0032; sq r = 0.90). Slightly larger D sub L was found in experiments with H2O replacing Cl than in experiments with Cl replacing H2O. D sub L at the lowest v was 2 orders of magnitude greater than D sub e. D sub T (sq cm/min) was essentially independent of v(d sub T = 0.0035v + 0.0031; sq r = 0.15) and was about 2 orders of magnitude greater than D sub e at the lowest v studied. The spread of tracer at the outflow was inversely proportional to v, and transverse dispersion had reduced the concentration peak of the inflow by 84% at L = 23 cm and v = 0.01 cm/min. The ratio D sub L/D sub T was proportional to v and ranged from about 1(v = 0.01 cm/min) to about 20 (v = 0.28 cm/min).

78:02G-063
ANALYSIS OF A CAPILLARY HYSTERESIS MODEL BASED ON A ONE-VARIABLE DISTRIBUTION FUNCTION,
Mualem, Y., and Morel-Seytoux, H.J.
Colorado State University, Fort Collins, Engineering Research Center.
Water Resources Research, Vol. 14, No. 4, p 605-610, August, 1978. 11 fig, 12 ref.

Descriptors: *Hysteresis, *Soil moisture, *Model studies, *Mathematical models, *Theoretical analysis, Porous media, Soil water movement, Model calibration, Drying curves, Soil science.

Parlange's model corresponds to a special case of Mualem's similarity hypothesis f(psi sub w, psi sub d) = h(psi sub w)l(psi sub d) in which h(psi) is set at unity for all psi values. Interpreted in terms of the soil water domain theory, this assumption implies that the relative pore volume of the domains is distributed uniformly in respect to the wetting radius (or to psi sub w). In this paper, the proper mathematical equation was derived for calibrating the model from the experimental main drying curve. The applicability of Parlange's model for the soil water hysteresis was analyzed theoretically and extensively tested for different types of porous media. Theoretical hysteretic curves derived by direct implementation of Parlange's model were compared with experiments. These comparisons showed that Parlange's model contradicts well-known properties of the soil moisture characteristics. The good results reported by Parlange were not obtained when actual measured curves of the hysteresis loop were used. Whether the main branch of hysteresis for wetting or for drying is used in calibration, badly distorted shapes of hysteresis curves are obtained. Parlange's suggestion for calibrating the model on the basis of the main drying curve plus one additional point from the main wetting curve is considered too arbitrary to be reliable.

78:02G-064
A MATHEMATICAL TREATMENT OF INFILTRATION FROM A LINE SOURCE INTO AN INCLINED POROUS MEDIUM,
Zachmann, D.W.
Colorado State University, Fort Collins, Department of Mathematics.
Soil Science Society of America Journal, Vol. 42, No. 5, p 685-688, September-October, 1978. 3 fig, 1 tab, 15 ref, 31 equ.

Descriptors: Infiltration, Mathematical studies, Porous media, Hydraulic conductivity, Pressure head, Capillary action, Steady flow.

An exact mathematical solution was obtained for two-dimensional steady infiltration from a line source into an inclined porous medium with an impermeable lower boundary. Unsaturated hydraulic conductivity was assumed to be an exponential function of pressure head. Equations for a stream function and the pressure head were developed and stream lines and contours of constant pressure head were plotted for a sandy soil and a clay soil using inclinations of 5 degrees and 20 degrees from horizontal.

78:02G-065
SOLUTE TRAVEL-TIME ESTIMATES FOR TILE-DRAINED FIELDS: III. REMOVAL OF A GEOTHERMAL BRINE SPILL FROM SOIL BY LEACHING,
Jury, W.A., and Weeks, L.V.
California University, Riverside, Department of Soil and Environmental Sciences.
Soil Science Society of America Journal, Vol. 42, No. 5, p 679-684, September-October, 1978. 7 fig, 3 tab, 10 ref, 13 equ.

Descriptors: Ion exchange, Solutes, Travel time, Estimating, Brines, Leaching, Reclamation, Tile drainage, Ion transport, Soil water movement.

The time required to leach a slug of saline, sodic geothermal brine from the point of injection to the tile outlet of an artificially drained field was calculated. Sprinkler, complete, and partial ponding leaching methods were compared as a function of drain spacing and initial location of the spill. Calculated results were presented as dimensionless parameters which scale the drainage system dimensions and the soil water transport properties. Ponded leaching required more water, but less time to leach brine out of the system for all situations except where the brine spill occurs near the midpoint between tile lines. A simple calculation was proposed to estimate the leaching fluid volume required to remove excess Na(+) from the exchange complex. Good agreement was attained between simulated and experimental results involving a laboratory soil column. It was estimated that for fine-textured soils in the Imperial Valley of California it may require up to 30 pore volumes of leaching fluid to replace Na(+) with Ca(2+) if saturated gypsum solution is used in reclamation. Application time per pore volume was calculated to be in excess of 1 year for all cases except ponded leaching directly over a tile line.

78:02G-066
DISPLACEMENT OF SOIL WATER BY SIMULATED RAINFALL,
Quisenberry, V.L., and Phillips, R.E.
Clemson University, South Carolina, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 5, p 675-679, September-October, 1978. 3 fig, 3 tab, 15 ref, 1 equ.

Descriptors: Soil water movement, Simulated rainfall, Tracers, Soil water, Moisture content, Laboratory tests.

Displacement of initial soil water by simulated rainfall was measured in aggregates of Maury silt loam soil in columns in the laboratory and under field conditions using tritiated water and/or Cl- as a tracer of added water. Displacement values measured in aggregates were larger (53 to 85%) than those measured under field conditions (7 to 56%). Percent displacement of initial soil water in Calloway silt loam under field conditions were similar to those of Maury, but were larger in Huntington silty clay loam than in Maury. Initial soil water content of Maury soil did not appear to affect percent displacement. Percent displacement in Maury soil increased as the depth of tillage increased.

78:02G-067
THE DEPENDENCE OF THE PARAMETERS IN THE GREEN AND AMPT INFILTRATION EQUATION ON THE INITIAL WATER CONTENT IN DRAINING AND WETTING STATES,
Aggelides, S., and Youngs, E.G.
Cambridge University, Cambridge, England, Department of Applied Biology.
Water Resources Research, Vol. 14, No. 5, p 857-862, October, 1978. 10 fig, 1 tab, 22 ref, 18 equ.

Descriptors: Infiltration, Infiltration rates, Moisture content, Soil water movement, Drying, Wetting, Hysteresis.

The parameters in the Green and Ampt infiltration equation were determined from infiltration experiments in a sand column at various uniform initial water contents in both draining and wetting states and were compared with various estimate obtained from the soil water properties measured on the same experimental column. The estimates of the soil water pressure head at the wetting front were generally more negative than the values obtained from the directly measured parameters. It was found that the calculated cumulative infiltration as a function of time was fitted better by using Bouwer's crude "water entry" estimate than values deduced by approximating Richards' flow equation.

78:02G-068
CLIMATE, SOIL, AND VEGETATION 3. A SIMPLIFIED MODEL OF SOIL MOISTURE MOVEMENT IN THE LIQUID PHASE,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 722-730, October, 1978. 13 fig, 15 ref, 62 equ.

Descriptors: Soil water movement, Mathematical models, Porous media, Water balance, Infiltration, Capillary action, Analytical techniques, Climatic data, Soil properties, Vegetation.

Natural soil systems were modeled one dimensionally from the surface to a stationary water table by a homogeneous medium defined by three independent parameters. Four varieties of soil moisture movement were analyzed separately, and their effects were linearly superimposed. Infiltration and exfiltration were described by the Philip equation, which assumed the medium to be effectively semi-infinite and the internal soil moisture at the beginning of each storm and inter-storm period was assumed to be uniform at its long-term space-time average. The exfiltration equation was modified for the presence of natural vegetation through the approximate introduction of a distributed sink representing the moisture extraction by plant roots. Gravitational percolation to groundwater was assumed to be steady throughout the rainy season at a rate determined by the long-term space-time average soil moisture. Capillary rise from the water table was assumed to be steady throughout the year and to take place to a dry surface.

78:02G-069
CLIMATE, SOIL, AND VEGETATION 6. DYNAMICS OF THE ANNUAL WATER BALANCE,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 749-764, October, 1978. 11 fig,
4 tab, 20 ref, 74 equ.
(See 78:02A-008)

78:02G-070
CLIMATE, SOIL, AND VEGETATION 7. A DERIVED DISTRIBUTION OF ANNUAL WATER YIELD,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 765-776, October, 1978. 10 fig,
3 tab, 13 ref, 35 equ.
(See 78:02A-007)

78:02G-071
A TWO-ELEMENT CERAMIC SENSOR FOR MATRIC POTENTIAL AND SALINITY MEASUREMENTS,
Scholl, D.G.
Forest Service, United States Department of Agriculture, Albuquerque, New Mexico,
Rocky Mountain Forest and Range Experimental Station.
Soil Science Society of America Journal, Vol. 42, No. 3, p 429-432, May-June,
1978. 3 fig, 6 ref.

Descriptors: *Soil moisture meters, *Saline soils, *Salinity, *Soil moisture, *Salinity sensor, *Soil moisture sensor, *Coalmine spoil, *Salinity meter, *Matric potential sensors, Salinity measurements.

A two-element ceramic sensor was developed to produce optimum electrical response to both soil water matric potential and salinity. A spring-loaded housing was developed for the elements for either drill-hole or pit-face placement. The sensors were calibrated under various matric potential, salinity, and temperature conditions. An initial field test with 72 sensors was conducted under irrigated coal mine spoil conditions. Laboratory and field results indicated reasonable instrument precision over a wide range of matric potential and salinity. The correlation between sensor output and water content in the field was best where the mean of several sensors was used.

78:02G-072
DERIVATION OF EQUATIONS FOR VARIABLE RAINFALL INFILTRATION,
Morel-Seytoux, H.J.
Colorado State University, Fort Collins, Engineering Research Center.
Water Resources Research, Vol. 14, No. 4, p 561-568, August, 1978. 7 fig, 2 tab,
9 ref, 41 equ, 1 append.

Descriptors: Infiltration, Infiltration rates, Rainfall, Ponding, Estimating equations, Soil water movement, Mathematical models.

Formulae were derived for prediction of ponding time and cumulative infiltration following ponding under a condition of piecewise variable and even intermittent rainfall. The derivatives do not assume immediate saturation at the surface or a piston displacement of air by water; they include the viscous flow of air. The results were compared with experimental data of James and Larson (ASAE Winter Meeting Paper, Chicago, Illinois, 1974) for two conditions: constant rainfall and intermittent rainfall. The proposed formulae are simple to use, requiring no complex solution of a partial or even an ordinary differential equation. The numerical calculations presented in the paper were performed with a small pocket calculator. The agreement with experimental data is good.

78:02G-073
EMPIRICAL EQUATIONS FOR SOME SOIL HYDRAULIC PROPERTIES,
Clapp, R.B., and Hornberger, G.M.
Virginia University, Charlottesville, Department of Environmental Sciences.
Water Resources Research, Vol. 14, No. 4, p 601-604, August, 1978. 2 fig, 2 tab,
15 ref, 7 equ.

Descriptors: Soil physical properties, Hydraulic properties, Soil moisture, Hydraulic conductivity, Infiltration, Air entrainment, Moisture tension, Equations.

The soil moisture characteristic may be modeled as a power curve combined with a short parabolic section near saturation to represent gradual air entry. This two-part function--together with a power function relating soil moisture and hydraulic conductivity--was used to derive a formula for the wetting front suction required by the Green-Ampt equation. Representative parameters for the moisture characteristic, the wetting front suction, and the sorptivity, a parameter in the infiltration equation derived by Philip (Soil Sci., 84, 257-264, 1957), were computed by using the desorption data of Holtan et al. (ARS 41-411, 609 pp., ARS, Beltsville, Maryland, 1968). Average values of the parameters, and associated standard deviations were calculated for 11 soil textural classes. The results of this study indicate that the exponent of the moisture characteristic power curve can be predicted reasonably well from soil texture and that gradual air entry may have a considerable effect on a soil's wetting front suction.

78:02G-074
CLIMATE, SOIL, AND VEGETATION 1. INTRODUCTION TO WATER BALANCE DYNAMICS,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 705-712, October, 1978. 8 fig, 16 ref, 23 equ.

Descriptors: Water balance, Dynamics, Climatic data, Vegetation, Stochastic processes, Probability, Soil moisture, Statistical methods, Soil-water-plant relationships, Soil properties.

A statistical dynamic formulation of the vertical water budget at a land-atmosphere interface was outlined. Physically based dynamic and conservation equations expressed the infiltration, exfiltration, transpiration, percolation to groundwater and capillary rise from the water table during rainstorms and interstorm periods in terms of independent variables representing the precipitation, potential evapotranspiration, soil and vegetal properties, and water table elevation. Uncertainty was introduced into these equations through the probability density function of the independent climatic variables and yielded derived probability distributions of the dependent water balance elements: surface runoff, evapotranspiration, and groundwater runoff. The mean values of these quantities gave a long-term average water balance which, to the first order, defined the annual water yield and water loss in terms of the annual precipitation and potential evapotranspiration and in terms of physical parameters of the soil, vegetation, climate, and water table. This analytical framework provides physical insight into the dynamic coupling of climate-soil-vegetation systems.

78:02G-075
ERRORS IN GAMMA-RAY MEASUREMENTS OF WATER CONTENT AND BULK DENSITY IN NONUNIFORM SOILS,
Nofziger, D.L.
Oklahoma State University, Stillwater, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 6, p 845-850, November-December, 1978. 7 fig, 1 tab, 6 ref, 7 equ.

Descriptors: Soil moisture, Soil water, Moisture content, Bulk density, Measurement, Stratification, Infiltration, Attenuation, Gamma rays, Clays.

Recent experimental study of freezing soils has shown gamma-ray measurements of water content and bulk density are in error when the water content and bulk density are not uniform throughout the gamma-ray beam. Many gamma-ray measurements involve nonuniform soils. This study was conducted to determine the magnitude of errors due to nonuniform bulk density and water content. Errors in gamma-ray water content and bulk density were determined for soil-water systems with linear and step-function changes in water content and bulk density and for measurements of water absorption by a nonswelling porous medium. Both single-energy and dual-energy gamma-ray systems were analyzed. The results showed that large errors in water content and bulk density determined by dual-energy gamma-ray measurements can occur for highly stratified soils and relatively small errors occur if the bulk density and water content change linearly in the collimated beam. Both single- and dual-energy systems accurately measured the average water content in the collimated beam when the bulk density of the soil was constant. However, the average water content in the beam did not always represent the water content at the middle of the collimated beam and the middle of the preset time period. Errors due to non-uniform soil can be evaluated using the equations and graphs presented.

78:02G-076
SEASONAL WATER USE BY WINTER WHEAT GROWN UNDER SHALLOW WATER TABLE CONDITIONS,
Saini, B.C., and Ghildyal, B.P.
G.B. Pant University of Agriculture and Technology, Pantnagar, Distr. Nainital, India.
Agricultural Water Management, Vol. 1, No. 3, p 263-276, November, 1978. 10 fig, 1 tab, 27 ref.

Descriptors: Water requirements, Soil water movement, Shallow water, Moisture tension, Water management (applied), Moisture content, Root zone, Tensiometers, Moisture deficit, Wheat.

Techniques for estimating seasonal water use from soil profile water depletion frequently do not account for flux below the root zone. A method using tensiometers for obtaining evapotranspiration losses from the root zone and water movement below it was discussed. Soil water flux below the root zone was approached by a sequence of pseudo steady state solutions of the flow equation. Upward soil water flux contributed 36 to 73% to the total water requirement of winter wheat (Triticum aestivum L.) whereas soil water depletion accounted for 11 to 19% only. Water use efficiency with one irrigation during an early stage of plant development was greater than with no or three irrigations. This was the result of both decrease of resistance due to soil moistening and better root development. Tensiometer readings were also interpreted to estimate root zones, water table depths and soil moisture contents. Methods described in this paper can be used in determining seasonal water use by growing crops, replacing or supplementing lysimeter or meteorology approaches to this problem.

78:02G-077
CONVECTIVE TRANSPORT OF SOLUTES BY STEADY FLOWS I. GENERAL THEORY,
Raats, P.A.C.
Institute for Soil Fertility, Oosterweg 92, Haren, The Netherlands.
Agricultural Water Management, Vol. 1, No. 3, p 201-218, November, 1978. 3 fig, 1 tab, 10 ref, 64 equ.

Descriptors: Soil water movement, Solutes, Convection, Steady flow, Theoretical analysis, Anisotropy, Water quality, Travel time, Leaching, Drainage.

A comprehensive theory describing convective transport of solutes was presented. The time required for a parcel of water to move from one point to another along a streamline was determined, and this basic information was then used to describe collections of parcels of water forming a surface. Input-output relationships were determined in terms of the distribution of the solute over the inflow and outflow surfaces. A simple geometric transformation was used to extend the theory to anisotropic media.

78:02G-078
CONVECTIVE TRANSPORT OF SOLUTES BY STEADY FLOWS II. SPECIFIC FLOW PROBLEMS,
Raats, P.A.C.
Institute for Soil Fertility, Oosterweg 92, Haren, The Netherlands.
Agricultural Water Management, Vol. 1, No. 3, p 219-232, November, 1978. 5 fig, 31 ref, 27 equ.

Descriptors: Soil water movement, Solutes, Convection, Steady flow, Drainage, Leaching, Flow characteristics, Flow system, Travel time.

A comprehensive theory describing convective transport of solutes was presented in Part I (Agric. Water Manage., 1:201-218). In this paper, the general theory was applied to specific flow problems. The relatively simple problem of leaching to drains and ditches induced by an input distributed uniformly over the surface was discussed in detail. It was shown that if the ratio of the halfspacing between the drains or ditches and the depth to the impermeable layer is larger than about five, density distribution is approximately exponential. The general theory was also used to evaluate the literature on many other problems.

78:02G-079
SOIL WATER RETENTION AS RELATED TO PARTICLE SIZE IN SELECTED SANDS AND LOAMY SANDS,
Rivers, E.D., and Shipp, R.F.
Bureau of Reclamation, Bismark, North Dakota, Missouri-Souris Projects Office.
Soil Science, Vol. 126, No. 2, p 94-100, August, 1978. 1 fig, 3 tab, 7 ref.

Descriptors: *Soil water, *Particle size, *Soil texture, *North Dakota, *Soil water retention, *Glacial Lake Souris basin (ND), Retention, Field capacity, Soils, Loam.

Sands and loamy sand within the Glacial Lake Souris basin in North Dakota vary considerably from one area to another in their particle size distribution. The objective was to relate water retention of these sandy soil textural classes to particle size percentage. Water retention percentages, on an over-dry basis, were determined for samples at field capacity under field conditions and also at 1/10-, 1/15-, and 1/20-bar soil water suction for air-dried, less than 2-mm samples in conventional porous ceramic plate-pressure pot equipment. No single soil water suction produced water retention values adequately representing field capacity for all textures. In most instances, the percentage of very fine sand alone and in combinations with the percentages of silt and clay were correlated significantly with soil water values.

78:02G-080
THE DEPENDENT DOMAIN THEORY APPLIED TO SCANNING CURVES OF ANY ORDER IN HYSTERETIC SOIL WATER RELATIONSHIPS,
Poulovassilis, A., and El-Ghamry, W.M.
Agricultural Research Council, Cambridge, England, Unit of Soil Physics.
Soil Science, Vol. 126, No. 1, p 1-8, July, 1978. 9 fig, 13 ref.

Descriptors: *Soil water, *Hysteresis, *Model studies, Mathematical models, Wetting, Drying, Moisture content, Pressure, Pore pressure, Theoretical analysis.

The dependent domain theory was extended to cover scanning curves of any order in the hysteretic relationship between soil water content, theta, and pressure, P. It was argued that if the distribution function, F, for the domains depends on the most recent reversal value of P, than F depends also on all the previous reversalt values. Experimental primary scanning curves and scanning curves of the first, second, and third orders of the relationship between theta and P for a sand were presented, and the hysteretic behavior of this experimental relationship was compared with that predicted by the dependent domain theory.

78:02G-081
PREDICTED AND MEASURED DRAINABLE POROSITIES FOR FIELD SOILS,
Skaggs, R.W., Wells, L.G., and Ghate, S.R.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Transactions of the American Society of Agricultural Engineering, Vol. 21, No. 3, p 522-528, May-June, 1978. 8 fig, 3 tab, 12 ref.

Descriptors: *Porosity, *Soil properties, *Drainage, *Model studies, *Drainable porosities, Laboratory tests, Soil water movement, Water table, Soil science, Soils.

Experiments were conducted on large field cores to determine the relationship between drainage volume and water table depth for five soils. The measured drainage volumes were less than predicted from the soil water characteristics for three soils, but were in good agreement for the other two. Drainable porosities were calculated from both theoretical and experimental drainage volume-water table depth relationships by assuming that the unsaturated zone is essentially "drained to equilibrium" with the water table. The experimental drainable porosities thus obtained were less than predicted. Drainable porosities for drainage to two-dimensions were calculated from experimental results for one dimension by assuming an elliptical water table profile. These results gave nearly constant drainable porosities for the layered soils and a variable drainable porosity for Wagram, a homogeneous, sandy soil.

78:02G-082
TIME OF SPREAD RELATIONSHIP IN IRRIGATION CHECK BASINS,
Sharma, T.C.
Guelph University, Ontario, Canada.
Transactions of the American Society of Agricultural Engineers, Special Edition,
Vol. 21SW, No. 3, p 505-509, June 20, 1978. 3 fig, 4 tab, 5 ref, 10 equ.

Descriptors: Basins, Irrigation, Dimensional analysis, Time, Infiltration, Estimating, Estimating equations.

Time of spread of water in a check basin is of vital importance for designing efficient check basin irrigation system. The analytical solutions for determination of time of spread tend to be quite complex and impractical due to the unsteady spatially varied nature of flow on nearly zero slopes of the land. In this study, the technique of dimensional analysis was used to derive time of spread relationships in check basins.

78:02G-083
INTAKE CHARACTERISTICS OF IRRIGATION FURROWS.
Fangmeier, D.D., and Ramsey, M.K.
Arizona University, Tucson, Department of Soils, Water and Engineering.
Transactions of the American Society of Agricultural Engineers, Special Edition,
Vol. 21SW, No. 4, p 696-700, 705, August 20, 1978. 3 fig, 3 tab, 5 ref, 19 equ.

Descriptors: Infiltration, Intakes, Furrow irrigation, Infiltration rates, Furrows, Estimating equations.

Seven irrigations were conducted on precision field furrows. Water volume balances were used to calculate infiltration and intake functions. The Philip equation provided a slightly better estimate of infiltration than the Kostiakov equation, but the constants in the Philip equation were more difficult to obtain. The intake rate appeared to be linearly related to the wetted perimeter for the irrigations conducted.

78:02G-084
VARIABILITY OF SOIL WATER RETENTION CURVES AND PREDICTED HYDRAULIC CONDUCTIVITIES ON A SMALL PLOT,
Cameron, D.R.
Research Station, Research Branch, Agriculture Canada, Swift Current, Saskatchewan S9H 3X2.
Soil Science, Vol. 126, No. 6, p 364-371, December, 1978. 3 fig, 4 tab, 19 ref.

Descriptors: Soil moisture, Soil water, Moisture content, Moisture tension, Hydraulic conductivity, Drying, Wetting, Retention, Soil water movement.

Soil water retention curves were measured on cores taken from five sites at six depths in a Bainsville clay loam soil. There were differences in both the shape and magnitude of the average moisture characteristic curves from one location to another in the 225 sq m plot. Coefficients of variation ranged from 4.2 to 13% in the surface layers and from 2.4 to 6.5% in the deeper layers. There were no consistent trends in variability with respect to tensions from 0 to -500 cm H2O. Predicted and measured hydraulic conductivity functions were variable, often showing a 100-fold difference at a given water content. The measured K functions were steeper than those predicted, and the match between them was considered reasonable only at the lower water contents.

78:02G-085
THEORY AND SYSTEM OF AUTOMATIC DETERMINATION OF SOIL MOISTURE CHARACTERISTICS AND UNSATURATED HYDRAULIC CONDUCTIVITIES,
Boels, D., Van Gils, J.B.H.M., Veerman, G.J., and Wit, K.E.
Institute for Land and Water Management Research (ICW), P.O. Box 35, Wageningen, The Netherlands.
Soil Science, Vol. 126, No. 4, p 191-199, October, 1978. 6 fig, 3 tab, 24 ref, 11 equ.

Descriptors: Soil moisture, Moisture content, Water pressure, Soil water, Soil water movement, Unsaturated flow, Hydraulic conductivity, Infiltration, Core.

The moisture characteristic and the unsaturated hydraulic conductivity were calculated from the measured water pressures at different depths in a soil core and the weights during evaporation at the top of the core. The measured water pressure was assumed to represent the mean pressure in a layer of a certain thickness, and the moisture characteristic was assumed to be described with sufficient accuracy by a polynom. The tangent of the polynom in each pressure interval was solved from a set of equations. The water pressure at different depths was measured with one pressure transducer, connected with a scannivalve; the weight was measured with a strain-gauge load cell; and the data were recorded on a magnetic cassette tape. The recorded data were processed by a computer and stored on a magnetic disc. When the saturated conductivity was relatively high, a steady-state infiltration method was applied to determine the unsaturated hydraulic conductivity at high water contents.

78:02G-086
TRANSPORT OF REACTIVE SOLUTES DURING TRANSIENT UNSATURATED WATER FLOW IN MULTILAYERED SOILS,
Selim, H.M.
Louisiana State University, Baton Rouge, Department of Agronomy, Louisiana Agricultural Experiment Station.
Soil Science, Vol. 126, No. 3, p 127-135, September, 1978. 10 fig, 14 ref, 19 equ.

Descriptors: Soil water movement, Soil water, Unsaturated flow, Unsteady flow, Infiltration, Adsorption, Mathematical models.

A numerical model was developed to predict water and reactive solute transport through water-unsaturated, multilayered soils. An explicit-implicit finite difference approximation method was used to solve the water and solute transport equations simultaneously. Calculated results were presented for two-and three-layered soils during water infiltration and redistribution. Linear and nonlinear equilibrium adsorption, first-order kinetic reaction, and irreversible kinetic reaction were used to describe solute adsorption in individual soil layers. It was found that, for all adsorption mechanisms considered, concentration distribution during infiltration and redistribution was significantly influenced by the order in which the soil layers were stratified.

SECTION VIII

WATER CYCLE

LAKES (GROUP 02H)

78:02H-001
FIELD INVESTIGATION OF SELECTIVE WITHDRAWAL,
Ivey, G., and Imberger, J.
California University, Berkeley, Department of Mechanical Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY9, p 1225-1237, September, 1978. 4 fig, 3 tab, 6 ref, 5 equ, 2 append.

Descriptors: Reservoirs, Reservoir operation, Withdrawal, Reservoir releases, Diffusion, Viscous flow, Buoyancy, Australia.

An integral part of a reservoir management scheme is the specification of the nature and extent of the flow within the reservoir induced by withdrawing water at an outlet. The steady-state thickness and extent of the withdrawal layer were examined in this paper. Existing theory indicated that, throughout the study period, the withdrawal layer was in a steady state in the regime governed by a balance between buoyancy and viscous forces. A natural salt tracer in the water enables estimates of the mean withdrawal layer thickness over a 10-km (6.2-mile) length upstream from the sink for two different time periods. To achieve good agreement between theoretical predictions and field measurements, it was necessary to postulate transport coefficients of momentum approximately ten times the molecular value. Comparisons with model simulations over the same time period suggested an effective average Prandtl number of 20 in the hypolimnion.

78:02H-002
ON THERMAL STRATIFICATION IN RESERVOIRS DURING THE WINTER SEASON,
Rahman, M.
National Research Council of Canada, Ottawa, Ontario, Division of Mechanical Engineering.
Water Resources Research, Vol. 14, No. 2, p 377-380, April, 1978. 2 fig, 5 ref.

Descriptors: *Thermal stratification, *Reservoirs, *Seasonal, *Diffusivity, *Boundary processes, *Temperature profile, Numerical analyses, Heat flux, Initial temperature, Ice.

A one-dimensional mathematical model describing the thermal structure in stratified reservoirs during the winter season was considered. With the help of this model, an attempt was made to clarify some of the physical factors which strongly influence the temperature profiles in reservoirs. It has been observed that there are many factors which influence the shape of the vertical temperature distribution, namely, the profile at the time of ice formation, the heat exchange by diffusion in the water mass, the heat exchange due to inflow and outflow of water in reservoirs, etc. This model accounts for a qualitative assessment of the possible effects of diffusivity and the initial shape of the temperature profiles on the variation of the vertical temperature distribution.

SECTION IX

WATER CYCLE

WATER AND PLANTS (GROUP 02I)

78:02I-001
IRRIGATION EFFECTS ON VEGETATIVE AND REPRODUCTIVE DEVELOPMENT OF THREE SOYBEAN CULTIVARS,
Ashley, D.A., and Ethridge, W.J.
Goergia University, Athens, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 467-471, May-June, 1978. 6 tab, 13 ref.

Descriptors: Soybeans, Supplemental irrigation, Growth stages, Plant growth, Irrigation effects.

This field experiment considered four moisture regimes--no irrigation, full season irrigation, irrigation starting at bloom stage, and irrigation starting at pod fill stage-on three soybean cultivars, "Ransom", "Hamptom 266A", and "Coker 102". Data were collected for seed yield, pod number and dry weight, dry weight of vegetative components during reproductive development and seasonal soil moisture status. The soil was a sandy loam. Full season and bloom stage irrigation treatments produced higher yields than the unirrigated check except for Hamptom 266A in 1974. Yields from plants receiving the podfill stage irrigation treatment were higher than the unirrigated check in drier seasons of 1972 and 1973 but not in 1974. Irrigation beginning at pod fill produced yields equal to the full season and bloom stage treatments in some cases and somewhat lower yields in other cases. Water application prior to blooming greatly increased vegetative dry weight, number, and dry weight of pods. Beginning irrigation during reproductive development had little effect on vegetative dry weight, but usually resulted in a greater number of pods late in the season than the unirrigated check. Higher yields and greater response to irrigation were obtained from shorter Ransom plants than the other two cultivars.

78:02I-002
IRRIGATION TIMING--ITS INFLUENCE ON THE EFFECTS OF SALINITY AND WATERLOGGING STRESSES IN TOBACCO PLANTS,
West, D.W., and Black, J.D.F.
Horticultural Research Institute, Victoria, Australia, Department of Agriculture.
Soil Science, Vol. 125, No. 6, p 367-376, June, 1978. 1 fig, 4 tab, 33 ref.

Descriptors: Saline water, Water quality, Sodium chloride, Drainage, Soil-water-plant relationships, Oxygen, Irrigation, Diffusion, Growth chambers, Tobacco.

The effects of irrigation timing on the interaction between salinity and waterlogging, and changes in the oxygen status in the root zone of a heavy soil under tobacco plants irrigated with drip system were studied. Water uptake was significantly reduced by the presence of NaCl in the root zone irrespective of irrigation and drainage treatment. Leaf chloride in all nonsalinized treatments was significantly lower than in all salinized treatments. Both day and night waterlogged saline treatments contained significantly higher leaf chloride than the nonwaterlogged saline treatment. The night-waterlogged saline treatment contained significantly lower leaf chloride than the day-waterlogged saline treatment. Similar trend to high Cl(-) content with day waterlogging was present with petioles and stems. Root Cl(-) concentrations were relatively low irrespective of treatment. Leaf sodium concentrations were relatively low irrespective of treatment. Leaf sodium concentrations of day- and night-waterlogged saline treatments were significantly higher than all other treatments, and the day-waterlogged salinized plants had significantly higher leaf Nat than the night-waterlogged salinized plants. The results suggests that plants in a soil with some chance of being waterlogged in the root zone and with NaCl present in the root zone would benefit from being irrigated at night rather than during the day.

78:02I-003

CROP WATER REQUIREMENT IN RELATION TO CLIMATE AND SOIL,

Shalhevet, J., and Bielorai, H.
Institute of Soils and Water, Bet Dagan, Israel, ARO-The Volcani Center.
Soil Science, Vol. 125, No. 4, p 240-247, April, 1978. 2 fig, 4 tab, 22 ref.

Descriptors: Water requirements, Yield equation, Climatic data, Soil properties, Cotton, Sorghum, Grapefruit, Evapotranspiration, Evaporation, Pans, Correlation analysis.

The effect of variation in climate and soil on the production function of water for the yield of cotton, sorghum, and grapefruit was analyzed to determine the transferability of water requirement information, accumulated in Israel, to other regions of the world. A model giving relative yield (Y) as a linear function of relative evapotranspiration (E_t/E_0) for all climatic regions together was compared with regional relationships of Y to net water application. Y is the ratio of a treatment yield to the maximum yield obtained in an experiment; E_t and E_0 are the cumulative seasonal evapotranspiration, including a small drainage component, and pan evaporation, respectively. The correlation coefficients were high for field crops but smaller for citrus. About 90 percent of the variability in yield of field crops were attributed to differences in potential evapotranspiration and in irrigation amounts. No effect was found of variation in soil on crop yield due to the rather uniform water-storage capacity of soils of varying texture. It was proposed that the production functions obtained in Israel may be used in regions with similar climatic characteristics for a wide range of soils after accounting for climatic variations through pan evaporation estimates.

78:02I-004

SIMULATED FLOW THROUGH THE ROOT XYLEM,

Busscher, W.J., and Fritton, D.D.
Rutgers University, New Brunswick, New Jersey, Department of Soils and Crops.
Soil Science, Vol. 125, No. 1, p 1-6, January, 1978. 5 fig, 14 ref, 5 equ.

Descriptors: Xylem, Root systems, Flow resistance, Flow rates, Simulation analysis, Model studies, Water pressure, Evapotranspiration.

Flow through the xylem of a complex root system is simulated to measure xylem resistance to water flow, and to determine whether or not this resistance is significant. Equations are set up that model xylem water flow as if it were flow through thin tubes. The root characteristics needed to solve these equations are obtained from an earlier work. Xylem water flow is first considered for a single main root and its laterals. It decreases with age of the root or increase of root length, and it increases with the addition of laterals. The advantage of an increasing number of main roots is also shown. Finally, flow through the plant crown is compared to Thornthwaite and Blaney-Criddle evapotranspirational estimates. Less than 10 millibars of water pressure is needed to overcome xylem resistance, and, therefore, the resistance is considered negligible.

78:02I-005

RELATIONSHIP BETWEEN SOIL TEST AND SMALL GRAIN RESPONSE TO P FERTILIZATION IN FIELD EXPERIMENTS,

Fixen, P.E., and Carson, P.L.
South Dakota State University, Brookings, Department of Plant Science.
Agronomy Journal, Vol. 70, No. 5, p 838-844, September-October, 1978. 3 fig, 8 tab, 35 ref.

Descriptors: Soil tests, Fertilization, Phosphorus, Grains (crops), Correlation analysis, Regression analysis, Climatic data, Soil properties, Crop response, Organic matter.

Yield data from 74 small grain field experiments over a 13-year period were used to evaluate the relationship between various soil tests and P response. The soil tests examined in this study were the Bray 1 (soil to solution ratio of 1:7, 1:10, 1:20, and 1:50), Olsen P, and P sorption index of Bache and Williams. The crop species included were Triticum aestivum L., Hordeum vulgare L., and Avena sativa L. The highest correlation between soil test value and yield response P fertilization was found with the Bray 1, 1:50 ($r^2 = 0.41$). An additional 23% of the yield response variation could be explained by including six additional variables in a multiple regression analysis employing dummy variables. The r value between P sorption index and yield response on alkaline soils was -0.70 but was near zero for acid soils. Differences were also noted in degree of response between parent materials and crop species. Organic matter content appeared to influence response on some soils.

78:02I-006
ALFALFA WATER USE AND PRODUCTION ON DRYLAND AND IRRIGATED SANDY LOAM,
Bauder, J.W., Bauer, A., Ramirez, J.M., and Cassel, D.K.
North Dakota State University, Fargo, Department of Soils.
Agronomy Journal, Vol. 70, No. 1, p 95-99, January-February, 1978. 2 fig, 3 tab, 12 ref.

Descriptors: Alfalfa, Irrigation effects, Soil-water-plant relationships, Moisture stress, Evapotranspiration, Fertilization, Crop production, Great Plains, Correlation analysis.

This study was carried out on a Maddock sandy loam soil, a member of the sandy, mixed frigid Udorthentic Haploborolls. Four irrigation levels, ranging from dryland to excessive irrigation, were established as whole plots in a randomized block, split plot design. Eight different fertilizer treatments of P, K, and S were applied to split plots during the 1st year of the study. Under a three harvest per season management system dry matter yield was significantly affected by harvest number and irrigation treatment each year. Within the dryland and deficient irrigation treatment by year, yields decreased with each cutting; with optimum and excessive irrigation, yields varied inconsistantly with cutting, yields increased 14 to 330% over dryland by increasing irrigation applications. When plant water stress existed throughout the growing season, relative yield correlated with relative evapotranspiration in a near perfect, linear manner. Under nonstress conditions, irrigation, growing season precipitation, and soil water depletion required consideration to attain nearly perfect correlation of relative yield with relative evapotranspiration. The results of this study indicated that under plant water stress conditions, alfalfa dry matter yield is a linear function of plant water use.

78:02I-007
NUTRIENT UPTAKE BY GRASS AND LEACHING LOSSES FROM SOLUBLE AND S-COATED UREA AND KCl,
Allen, S.E., Terman, G.L., and Kennedy, H.G.
National Fertilizer Development Center, TVA, Muscle Shoals, Alabama, Soils and Fertilizer Research Branch.
Agronomy Journal, Vol. 70, No. 2, p 264-268, March-April, 1978. 4 fig, 4 tab, 6 ref.

Descriptors: Leaching, Fescues, Sudangrass, Nutrients, Fertilizers, Nitrogen, Potassium, Crop response, Lysimeters, Ureas.

Slow-release fertilizers should provide for more efficient nutrient use by the crop as well as reduce leaching losses. This study was conducted to measure crop response to N or K in uncoated urea, ammonium nitrate, S-coated urea, and S-coated KCl and to relate leaching losses to NO3 - N and cations. In one series, granular N sources to supply 200 or 400 kg of N/surface ha were mixed with the upper 20 cm of a 1:1 mixture of Norfolk sl (Typic Paleudult) and builders sand contained in 15 cm by 120 cm columns. A second series was similarly fertilized with K sources to supply 100 or 200 kg of K/surface ha.

78:02I-008
ROOT-SINK DESCRIPTIONS OF WATER SUPPLY TO DRYLAND WHEAT,
Rickman, R.W., Allmaras, R.R., and Ramig, R.E.
Oregon State University, Pendleton, Columbia Plateau Conservation Research Center.
Agronomy Journal, Vol. 70, No. 5, p 723-728, September-October, 1978. 11 fig, 13 ref, 4 equ.

Descriptors: Moisture uptake, Wheat, Moisture tension, Soil water movement, Soil profiles, Root distribution, Dry farming, Soil-water-plant relationships, Sink, Hydraulic conductivity.

Soil water content changes were supplemented with calculations of water flow between soil layers to provide an improved description of water uptake by dryland wheat (Triticum aestivum L.). Water content changes were estimated from neutron meter measurements. Soil water flux was estimated from field measurements of both hydraulic conductivity and hydraulic head gradients; unsaturated conductivity beyond the range of field measurement was calculated with the pore interaction model of Marshall matched to field measured values at 250 mb. Seasonal water-uptake patterns, determined by the root-sink description, differed from those shown by only water content measurements. Peak water-use rates did not coincide with maximum leaf area index, but coincided with the period from heading to completed head extension. Water flux in the profile was important for supplying water during grain filling and was critical in this layered soil, which restricted rooting to depths less than 150 cm.

78:02I-009
FERTILIZER PLACEMENT EFFECTS ON SOYBEAN SEED YIELD, N_2 FIXATION, AND 33P UPTAKE,
Ham, G.E., and Caldwell, A.C.
Minnesota University, St. Paul, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 5, p 779-783, September-October, 1978. 2 fig, 4 tab, 20 ref.

Descriptors: Nitrogen fixation, Soybeans, Phosphorus, Radioisotopes, Fertilizers, Ureas, Seeds, Productivity.

This study was planned to evaluate the efficiency of P fertilizer utilization by field-grown soybeans with different fertilizer placements using 33P labelled fertilizer (35 kg P/ha) on a Waukegan silt loam soil (Typic Hapludoll) low in plant available N and P. In addition, urea (30 kg N/ha) labelled with 15N was added to measure the effect of P fertilizer placement on N uptake and N2 fixation using the "A" value concept concerning the measurements of available soil nutrients developed by Fried and Dean (1952). Soybean seed yield and total P uptake were increased significantly by adding P fertilizer with no differences among the fertilizer placements (seed yield ranged from 3,811 to 4,035 kg/ha compared to 3,200 kg/ha for the control). The 33P labelled fertilizer provided a direct, quantitative measure of the efficiency of plant use of the added P and provided a basis of evaluating the fertilizer placements without the hazards associated with 33P over the 149-day experiment. The "A" value concept provided a reliable estimate of N2 fixation which agreed with Kjeldahl measurements.

78:02I-010
DIFFERENTIAL RESPONSE OF SOYBEAN VARIETIES TO SOIL CADMIUM,
Boggess, S.F., Willavize, S., and Koeppe, D.E.
Illinois University, Urbana, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 5, p 756-760, September-October, 1978. 1 fig, 5 tab, 30 ref.

Descriptors: Cadmium, Toxicity, Soybeans, Varieties, Crop response, Sewage sludge, Soil amendments, Trace elements.

This paper presents the results of a comprehensive survey of the Cd uptake and effect by a number of the prominent soybean (Glycine max (L.) Merrill) varieties grown on several CdCl2 or sewage slude-amended soils in the glasshouse. In all varieties, Cd toxicity symptoms appeared as a continuum from slight effects observed as a red, red-brown, or purple coloration at the junction of the leaf blade and petiole, to severe leaf curling and extensive reddening of the leaf veins, chlorosis, and finally a brittle condition followed by abscission of the leaves. All varieties showed increased shoot Cd concentration and decreased dry weight in response to soil CdCl2, but varietal differences in the severity of these Cd effects were observed. Further analysis of data for Cd susceptibility suggested that, of the soybean varieties tested on CdCl2-amended soils, Dunfield, Harosoy, Arksoy, Dare, Flambeau, and Scioto were generally the most susceptible while Clark, Mandarin, Mukden, Jackson, and Lee were consistently ranked as less susceptible.

78:02I-011
SEEDLING EMERGENCE AS RELATED TO TEMPERATURE AND MOISTURE TENSION,
Wright, D.L., Blaser, R.E., and Woodruff, J.M.
Florida University, Quincy.
Agronomy Journal, Vol. 70, No. 5, p 709-712, September-October, 1978. 1 fig, 1 tab, 16 ref.

Descriptors: Erosion control, Grasses, Legumes, Highway beautification, Germination, Seeds, Moisture tension, Temperature.

To aid in selection of species for mixtures of seed for controlling erosion on newly constructed highway slopes, an experiment was designed to determine total emergence and rates of emergence of several grass and legume species and cultivars under various soil moisture and temperature regimes. The experimental observation suggested that the aggressive species of annual and perennial ryegrass, German millet, redtop, weeping lovegrass, and Abruzzi rye compete strongly with slower developing perennial grasses and legumes when seeded in the appropriate season. It was also observed that successful establishment of the intermediate species such as bluegrass, crownvetch, creeping red fescue, and Kentucky 31 tall fescue depends on cool temperatures and high moisture availability. Nonaggressive species of crownvetch and sericea also required high moisture and cool temperature, whereas common bermudagrass needed high moisture and warm temperatures. It was concluded that modification of seed mixtures should depend on the season of seeding and the type of vegetation desired, and that lower rates of agressive species should be used while seeding mixtures of aggressive species with slow-developing species when conditions favor rapid emergence and growth for both.

78:02I-012
DIFFERENCES AMONG GENOTYPES OF CORN IN THE KINETICS OF P UPTAKE,
Nielsen, N.E., and Barber, S.A.
The Royal Veterinary and Agricultural University, Copenhagen, Denmark.
Agronomy Journal, Vol. 70, No. 5, p 695-698, September-October, 1978. 6 tab, 23 ref, 1 equ.

Descriptors: Corn (field), Phosphorus, Simulation analysis, Soil properties, Root systems, Correlation analysis.

Many plant species utilize fertilizer of soil P inefficiently. A survey of 12 inbred corn genotypes (Zea mays L.) grown in water culture indicated a 1.8 to 3.3-fold variation in root weight, root length per unit of plant weight, root length per unit of root weight, and maximal net P influx. Some aspects of the role of genetics were elucidated by comparing the P absorption parameters of five inbreds with those of four single-cross hybrids made from these inbreds. Five single crosses were grown at low and high P levels in the field on a Raub silt loam (Aquic Argiudoll) to test the significance of the measured root parameters on P uptake. Plants were harvested 22, 38 and 51 days after planting. Phosphorus uptake was also simulated by a model using soil and plant root parameters related to P uptake. The correlation between predicted and observed P uptake was r2 = 0.90 for the 22 to 38-day time interval and r2 = 0.98 for the 22 to 51-day time interval. Hence, observed differences among corn single crosses in their plant root parameters were reflected in their P uptake when grown in the field.

78:02I-013
TEMPERATURE DEPENDENCE OF WATER UPTAKE BY PLANT ROOTS,
Dalton, F.N., and Gardner, W.R.
Wisconsin University, Madison, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 3, p 404-406, May-June, 1978. 4 fig, 1 tab, 11 ref, 13 equ.

Descriptors: Moisture uptake, Root systems, Temperature, Solutes, Kinetics, Diffusivity.

The transport of water through root membranes is described in terms of equations which couple water and solute transport. The solute transport equation includes active as well as passive uptake. Temperature effects are manifested in the viscosity of water, the osmotic permeability coefficient of the membranes, and the rate constant for the active solute uptake. From standard reaction rate kinetics, reasonable estimates of the temperature coefficients of these three processes are made.

A general equation for the effect of temperature on the uptake rate for a given driving force is derived. This difference in flux between live and dead roots is adequately described by the model, indicating the significance of the active component of the uptake process.

78:02I-014
INFLUENCE OF K ON THE UPTAKE, TRANSLOCATION, AND REDUCTION OF NITRATE BY BARLEY SEEDLINGS,
Blevins, D.G., Hiatt, A.J., Lowe, R.H., and Leggett, J.E.
Kentucky University, Lexington, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 3, p 393-396, May-June, 1978. 5 fig, 1 tab, 17 ref.

Descriptors: Nitrates, Translocation, Reduction (chemical), Barley, Organic acids, Metabolism, Calcium, Potassium, Growth chambers.

The purpose of this study was to determine the influence of K or Ca on nitrate uptake, translocation, and reduction in barley seedlings. Six-day-old barley seedlings were grown for 2 to 36 hours in solutions of 1.0 meq/liter KNO3 or Ca (NO3)2, each containing 0.4 meq/liter of CaSO4. Experiments were conducted in a growth chamber at 27 C with a photosynthetic irradiance of 5.3 mW times cm-3. Seedlings treated with Ca(NO3)2 (low K) had lower levels of nitrate uptake, nitrate reductase activity, and lower organic acid concentrations than seedlings treated with 1 mM KNO3. The solution pH and the expressed sap pH of roots and shoots of the low K seedlings increased during the experiment. The shoots of the low-K seedlings had much lower nitrate concentrations and lower levels of nitrate reductase activity than the roots, suggesting that K plays a major role in nitrate translocation. These results support the hypothesis that potassium malate is cycled from the tops to the roots where decarboxylation occurs, providing a source of HCO3(-) for exchange with NO3(-) during absorption.

78:02I-015
RESPONSES OF STOMATA AND WATER, OSMOTIC, AND TURGOR POTENTIALS OF JOJOBA TO WATER AND SALT STRESS,
Adams, J.A., Bingham, F.T., Kaufmann, M.R., Hoffman, G.J., and Yermanos, D.M.
California University, Riverside, Department of Soil and Environmental Sciences.
Agronomy Journal, Vol. 70, No. 3, p 381-387, May-June, 1978. 4 fig, 2 tab, 42 ref.

Descriptors: Desert plants, Soil-water-plant relationships, Salt tolerance, Drought tolerance, Turgidity, Transpiration, Stomata, Xylem.

Jojoba (Simmondsia chinensis (Link) Schneider) is a desert shrub which can provide a much needed substitute for sperm whale oil. Because of the absence of soil-plant-water data for jojoba and the limited amount of such information for desert plants in general, selected plants were water-and-salt-stressed in greenhouse soil and sand culture experiments. Responses of leaf water, osmotic, and turgor potentials to stress and associated stomatal behavior were studied.

78:02I-016
FORAGE YIELD AND FERTILIZER RECOVERY BY THREE IRRIGATED PERENNIAL GRASSES AS AFFECTED BY N FERTILIZATION,
Hanson, C.L., Power, J.F., and Erickson, C.J.
Northwest Watershed Research Center, Boise, Idaho, United States Department of Agriculture.
Agronomy Journal, Vol. 70, No. 3, p 373-375, May-June, 1978. 3 tab, 5 ref.

Descriptors: Forage grasses, Hay, Nitrogen, Fertilization, Crop response, South Dakota.

The purpose of this study, conducted in western South Dakota on heavy clay soils was to determine forage yield responses and N recovery of three irrigated grasses--reed canarygrass, garrison creeping foxtail, and smooth brome--to single and split N applications. Single N treatments consisted of 0, 56, 112, 224, or 448 kg N/ha applied in March. For the split N applications, these same rates were applied both in March and again after the first hay cutting. Forage yields were maximum when the grasses were fertilized with 224 kg N/ha in the split applications. First cutting forage N percentage varied between 0.8 to 2.8 for N rates of 56 kg N/ha and above. The percentage of N was highest, frequently over 3%, in second cutting forage from treatments receiving split fertilizer applications. Percent total N recovered increased as fertilizer rate increased when all N was applied in March, but recovery was highest for the split application of 224 kg N/ha.

78:02I-017
EFFECT OF SLOW RELEASE FERTILIZER ON FERTILIZER RESIDUES AND ON YIELD AND COMPOSITION OF FLUE-CURED TOBACCO,
San Valentin, G.O., Robertson, W.K., Johnson, J.T., and Weeks, W.W.
Philippines University, Banos College, Laguna 3720, Philippines, Department of Agriculture.
Agronomy Journal, Vol. 70, No. 2, p 345-348, March-April, 1978. 9 tab, 7 ref.

Descriptors: Tobacco, Potassium, Fertilizers, Solubility, Nutrient removal, Sulfur.

Tobacco was grown for 5 years on Lakeland fine sandy soil, a soil which retains very little K. Split applications of K2SO4 were compared to single applications of K2SO4 and resin- polyvinyl-, and S-coated K materials. Yields and chemical composition of tobacco leaves and soil were used to measure the relative effectiveness of K treatments. Yields and K contents of tobacco leaves were increased by K fertilization. Split applications of K2SO4 were more effective than single applications at planting. In years with heavy rainfall, applying slowly-soluble sources all at planting was better than applying K2SO4 in split application. Potassium from slowly soluble materials was less readily leached than from K2SO4, resulting in higher concentration of K within 60 cm of the surface at the time of tobacco flowering. When various thickness of S were applied to give a range of K release, the thicker coatings gave higher yields. Treatments that provided higher K contents increased total alkaloids and decreased reducing sugars in the first of the two years that they were measured. Application of K fertilizers with reduced solubility should assure good yields, quality, and a high level of K in tobacco.

78:02I-018
DRY MATTER PRODUCTION AND TRANSLOCATION IN MAIZE SUBJECTED TO DROUGHT DURING GRAIN FILL,
Jurgens, S.K., Johnson, R.R., and Boyer, J.S.
Illinois University, Urbana, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 4, p 678-682, July-August, 1978. 5 fig, 5 tab, 17 ref.

Descriptors: Corn (field), Moisture stress, Moisture deficit, Photosynthesis, Translocation, Crop response, Crop production.

The objective of this research was to study the problem of yield loss to be expected and the physiological mechanism that cause the loss due to dry conditions most frequently occurring during the second half of the growing season of maize (Zea mays L.). Drought was imposed during the grain filling stage of maize to determine its relative effects on photosynthesis and translocation.

78:02I-019
EFFECTS OF SOIL WATER STRESS ON GROWTH AND NUTRIENT ACCUMULATION IN CORN,
Verasan, V., and Phillips, R.E.
Kasetsart University, Bangkok, Thailand, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 4, p 613-618, July-August, 1978. 6 fig, 10 ref.

Descriptors: Moisture stress, Moisture deficit, Corn (field), Plant growth, Nutrients, Plant physiology, Transpiration, Moisture tension.

The objective of this study was to more clearly delineate the effect of soil water stress on growth and accumulation of nutrient ions in corn. Corn was grown in the greenhouse in 20-liter pots containing soil from the Ap horizon of Maury silt loam (Typic Paleudalfs) under two soil moisture treatments, stressed and nonstressed. The relationship soil water potential and cumulative evapotranspiration with nutrient accumulation and dry matter production were more significant than the relationship of soil water potential with dry matter production and nutrient accumulation. Since water stress affects turgidity, photosynthesis, respiration, cell enlargement, and other physiological processes of the plant, it was concluded that cumulative transpiration is a better integrator of the effects of these processes on plant growth than is soil water potential.

78:02I-020
FIELD MEASURED AND SIMULATED CORN LEAF WATER POTENTIAL,
Reicosky, D.C., and Lambert, J.R.
Agricultural Research Service, Morris, Minnesota, United States Department of Agriculture.
Soil Science Society of America Journal, Vol. 42, No. 2, p 221-228, March-April, 1978. 6 fig, 2 tab, 27 ref.

Descriptors: Sweet corn, Simulation analysis, Moisture content, Moisture tension, Microenvironment, Stemflow.

The dynamic nature and magnitude of field-measured leaf water potential for sweet corn (Zea mays L.) was compared with that predicted by the model TROIKA. Some plant parameters for corn were estimated from the literature and field observation, whereas the moisture desorption curve and the hydraulic conductivity-water content relationship were determined for the Varina sandy loam. Leaf water potential-relative water content relationships were determined in the greenhouse. Hourly microclimate data were used as input to the model, and the predicted and observed value of leaf water potential were compared for 3 days during the growing season. Generally, the model predicted leaf water potential with reasonable accuracy throughout the day. Water potential gradients in the soil were small as compared with those across the root and across the stomatal opening.

78:02I-021
POTASSIUM UPTAKE BY ONION ROOTS CHARACTERIZED BY POTASSIUM/RUBIDIUM RATIO,
Baligar, V.C., and Barber, S.A.
Purdue University, Lafayette, Indiana, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 618-622, July-August, 1978. 8 tab, 15 ref, 3 equ.

Descriptors: Cations, Cation exchange, Potassium, Onions, Sweet corn, Selectivity, Diffusivity, Root systems.

A common belief is that plant roots absorb cations from the solution phase of the soil. Experiments with corn (Zea mays L.) using K/Rb ratio to evaluate the source of K and Rb absorbed indicated the plant roots absorbed these ions in the ratio of exchangeable K and Rb. The objective of this research was to study the source of K and Rb absorbed from soil by onion (Allium cepa) roots since they do not have root hairs and this may influence the uptake mechanism. Onions absorbed K/Rb with a ratio which was intermediate between the ratio of exchangeable K and Rb and the ratio of these cations in solution. In comparison with corn, onions absorbed K at one-third the rate, but absorbed water three times faster so that mass flow contributed a greater proportion of K absorbed by onions than that by corn. This, rather than differences in root hairs may be the reason for the observed differences in K uptake between corn and onions.

78:02I-022
UPTAKE OF CADMIUM FROM PHOSPHATE FERTILIZERS BY PEAS, RADISHES, AND LETTUCE,
Reuss, J.O., Dooley, H.L., and Griffis, W.
Corvallis Environmental Research Laboratory, Corvallis, Oregon 97330.
Journal of Environmental Quality, Vol. 7, No. 1, p 128-133, January-March, 1978. 2 fig, 7 tab, 6 ref.

Descriptors: Heavy metals, Phosphates, Fertilizers, Cadmium.

Cadmium uptake from phosphate fertilizers by radish, lettuce, and garden peas was investigated in the greenhouse. Reagent grade mono-calcium phosphate and concentrated superphosphate (CSP) were used as a P source on a coarse-textured acid soil. The effect of mono-calcium phosphate compared with that of CSP on radish, lettuce and peas was nonsignificant. On a medium-textured calcareous soil the use of this CSP increased the Cd content of radish tops by about 80% and that of lettuce by 50%.

The effect on radish roots from calcareous soil was nonsignificant. Pea seeds and foliage on this soil were below our Cd detection limit. Uptake on both soils was a linear function of the Cd content of the fertilizer. In the acid soils, spot placement of fertilizer in comparison to mixing it with the soil resulted essentially the same Cd uptake from CSP fertilizer. Spot placement of Di-ammonium phosphate (DAP) almost completely eliminated Cd uptake from the fertilizer. In the calcareous soil spot placement increased Cd uptake from the CSP fertilizer, but slightly depressed uptake from DAP.

78:02I-023
USE OF K/Rb RATIO TO CHARACTERIZE POTASSIUM UPTAKE BY PLANT ROOTS GROWING IN SOIL,
Baligar, V.C., and Barber, S.A.
Purdue University, West Lafayette, Indiana, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 575-579, July-August, 1978. 3 fig, 5 tab, 18 ref, 2 equ.

Descriptors: Potassium, Root systems, Root development, Moisture uptake, Ion exchange, Sweet corn, Growth chambers.

Interaction between the plant root and the soil on cation influx into the root is not well understood. Use of the ratio of K/Rb, two ions absorbed interchangeably by the root, enables measurement of the K ion medium influencing K influx into the root. In experiments with corn (Zea mays L.) grown in eight soil-K systems in a growth chamber, the K/Rb ratio of uptake was similar to the K/Rb ratio of the ions on the exchange sites, and not the K/Rb ratio of the solution cations. The data may be interpreted to indicate that K and Rb on the exchange sites had more influence on K and Rb flux into the root than K and Rb in solution. Diffusion of K and Rb from the soil to H-saturated exchange membranes was in the ratio of K/Rb in solution.

78:02I-024
GROWTH AND ELEMENTAL COMPOSITION OF CORN AND BEAN SEEDLINGS AS INFLUENCED BY SOIL APPLICATION OF COAL ASH,
Adriano, D.C., Woodford, T.A., and Ciravolo, T.G.
Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, South Carolina 29801.
Journal of Environmental Quality, Vol. 7, No. 3, p 416-421, July-September, 1978. 5 tab, 43 ref.

Descriptors: Coal mine wastes, Corn (field), Beans, Crop production, Soil chemical properties, Fossil fuels, Fly ash, Toxicity, Salinity, Deficient elements.

Analyses of 0.1N HCl extracts of ash (slag + fly ash) samples from bituminous coal revealed high concentrations of K, Ca, and Fe and intermediate concentrations of P, Mg, Cu, Mn, and Zn. Of the elements analyzed, the extractable concentrations increased as particle size decreased from >1,000 micron to <105 micron. The slightly acidic ashes were mixed with Troup sandy loam at rates of 5, 10, and 20% by weight and equilibrated in a glasshouse for 1 mo before planting. "Coarse" ash was used at only the 10% rate. Corn and bush bean yields from ash-amended soils were statistically equal to yields from a control treatment but significantly lower than fertilized treatment. Corn exhibited P deficiency symptoms while symptoms characteristic of B toxicity occurred in beans. Analyses of tissues of both crops indicated that P concentrations were at deficiency levels while Cu, Mn, and Zn were deficient to marginal. Iron, however, appeared to be in the normal range. Salinity as indicated by EC of leachate of 3 mmhos/cm or greater, B excess as indicated by the toxicity symptoms in beans, and P deficiency as indicated by low P concentrations in plant tissues could limit crop growth in ash-treated soils.

78:02I-025
CORN PRODUCTION AS INFLUENCED BY IRRIGATION AND SALINITY--UTAH STUDIES,
Hanks, R.J., Ashcroft, G.L., Rasmussen, V.P., and Wilson, G.D.
Utah State University, Logan, Department of Soil Science and Biometeorology.
Irrigation Science, Vol. 1, No. 1, August, 1978, p 47-59. 9 fig, 3 tab, 8 ref.

Descriptors: Irrigation, Salinity, Corn (field), Moisture stress, Moisture deficit, Growth stages, Saline water, Evapotranspiration, Crop production, Crop response.

This paper reported the results of a two-year field study at Logan, Utah which was one of a series of similar experiments carried out at Fort Collins, Colorado, Davis, California and Yuma, Arizona. A range of water application rates were imposed using a line-source system and in some treatments water was withheld during certain growth stages. Salinity variables were imposed by presalinization before planting and by the use of saline irrigation water. Regardless of irrigation or salinity regime, corn grain and total dry matter production were linearly related to evapotranspiration, which was measured as the sum of irrigation, rainfall and soil water depletion minus drainage. Presalinization of the soil decreased yields in proportion to the salinity imposed, the decrease being associated with reductions in evapotranspiration caused by reduced soil water depletion as compared to the nonsalinized treatments.

78:02I-026
THE EFFECT OF SUPPLEMENTAL IRRIGATION AND NITROGEN FERTILIZATION ON WHEAT (TRITICUM AESTIVUM L.),
Shimshi, D., and Kafkafi, U.
Regional Experiment Station, Agricultural Research Organization, Mobile Post Negev 2, Gilat, Israel.
Irrigation Science, Vol. 1, No. 1, August, 1978, p 27-38. 2 fig, 7 tab, 13 ref.

Descriptors: Supplemental irrigation, Fertilization, Nitrogen, Wheat, Crop response, Crop production, Growth stages.

During 1971/72 an experiment was conducted at the Gilat Regional Experiment Station in the Negev region of Israel, in which the combined effect of irrigation and nitrogen fertilizer on wheat was studied. The following aspects were investigated: the general nature of the interaction of irrigation and nitrogen on crop yields and the effect of nitrogen on water use and water relations of the wheat plant.

78:02I-027
EFFECTS OF CHELATED IRON ON THE GROWTH OF TWO SPECIES OF VALLISNERIA,
Dooris, P.M., and Martin, D.F.
South Florida University, Tampa, Department of Biology and Chemistry.
Water Resources Bulletin, Vol. 14, No. 5, p 1088-1093, October, 1978. 4 tab, 12 ref.

Descriptors: Aquatic plants, Iron, Nutrient requirements, Plant growth, Florida, Water management (applied).

Iron, added as (Fe-EDTA)(-), was found stimulatory to V. spiralis at a concentration of 0.05 ppm. (Fe-EDTA)(-) had no effect upon growth of V. neotropicalis as measured by changes in dissolved oxygen and dry weight. Results were compared with those derived from similar studies with Hydrilla verticillata and Egeris densa. The implications of lake drawdown and aeration were discussed.

78:02I-028
ABSORPTION RATES OF AMMONIUM AND NITRATE BY RED KIDNEY BEANS UNDER SALT AND WATER STRESS,
Frota, J.N.E., and Tucker, T.C.
Arizona University, Tucson, Department of Soil, Water and Engineering.
Soil Science Society of America Journal, Vol. 42, No. 5, p 753-756, September-October, 1978. 2 fig, 5 tab, 21 ref.

Descriptors: Salinity, Moisture stress, Absorption, Ammonium salts, Nitrates, Beans, Moisture deficit, Crop production, Crop response, Nitrogen.

The purpose of this study was to gain additional knowledge regarding the influence of salinity and water deficit on plant uptake of NH4(+) and NO3(-). The absorption patterns of NH4(+) and NO3(-) by red kidney beans (Phaseolus vulgaris L.) were determined under normal conditions (water stress) using an inverse isotope dilution technique with 15N. Salt and water stress inhibited the absorption of both NH4(+) and NO3(-). There was no difference between these two stress treatments in NH4(+) uptake, but carbowax restricted NO3(-) uptake more than did NaCl. Under NaCl salinity the plants absorbed the same amount of N independent of N source; under water stress more NH4(+) than NO3(-) was absorbed. Water absorption was reduced by both stress treatments; N and water uptake were highly correlated. Root permeability decreased in plants subjected to stress. Dry matter production and total N per plant decreased, but the N percentage increased in the stressed plants.

78:02I-029
SALT AND WATER STRESS INFLUENCES NITROGEN METABOLISM IN RED KIDNEY BEANS,
Frota, J.N.E., and Tucker, T.C.
Arizona University, Tucson, Department of Soils, Water and Engineering.
Soil Science Society of America Journal, Vol. 42, No. 5, p 743-746, September-October, 1978. 6 tab, 27 ref.

Descriptors: Salinity, Moisture deficit, Nitrogen, Metabolism, Beans, Crop production.

Both salinity and water deficit reduce yields of crop plants. This study was an attempt to provide a better understanding of these stress effects on N metabolism and the utilization of NH4-N and NO3-N. Red kidney bean plants (Phaseolus vulgaris L.) were grown under salt stress (NaCl), water stress (carbowax), and in a normal nutrient solution (control). The 15N in NO3(-), NH4(+), alpha amino acids, total soluble-N and protein-N in plant shoots were analyzed after the plants received 15(NH4)2SO4 and K15NO3 in nutrient solution for 6, 12, 24, and 48 hours. Sodium chloride and carbowax resulted in equal accumulations of NO3-N, NH4(+), and free alpha amino acids in bean shoots. Protein synthesis was significantly reduced in bean shoots when the plants were subjected to NaCl salinity and carbowax, with either source of N, and the inhibition was more severe under salt stress than water stress.

78:02I-030
TIMING AND RATE OF FERTILIZER NITROGEN FOR SUGARBEETS RELATED TO NITROGEN UPTAKE AND POLLUTION POTENTIAL,
Hills, F.J., Broadbent, F.E., and Fried, M.
California University, Davis, Department of Soil Microbiology.
Journal of Environmental Quality, Vol. 7, No. 3, p 368-372, July-September, 1978. 4 fig, 3 tab, 11 ref.

Descriptors: Nitrogen, Fertilization, Timing, Nutrient requirements, Sugar beets, Water pollution, Crop production, Tracers.

Nitrogen (N) uptake by sugarbeets (Beta vulgaris L.) from fertilizer and soil, as related to time and rate of application, was evaluated at Davis, California, in two field experiments utilizing 15N-deleted ammonium sulfate. There were no significant differences in root, top, or sugar yield when fertilizer N (135 kg/ha) was applied at planting, at thinning, split equally between thinning and layby, or split equally between planting, thinning, and layby. Also, there were no substantial differences in soil or fertilizer N in tops and roots in response to these dates of application. Fertilizer N recovery was 47% when 112 kg N/ha were applied to achieve maximum sugar yield. Roots removed as much N as that applied and tops contained an additional 105 kg N/ha. When applied N was 2.5 times the amount required for maximum sugar yield, tops and roots contained almost as much N as applied. The sugarbeet crop, carefully fertilized, has potential for alleviation of nitrate pollution of groundwater.

78:02I-031
WATER RELATIONS OF CADMIUM-TREATED PLANTS,
Kirkham, M.B.
Oklahoma State University, Stillwater, Department of Agronomy.
Journal of Environmental Quality, Vol. 7, No. 3, p 334-336, July-September, 1978. 2 fig, 1 tab, 21 ref.

Descriptors: Turgidity, Water pressure, Osmotic pressure, Cadmium, Transpiration, Soil-water-plant relationships.

Turgor pressures, stomatal resistances, and transpiration rates were measured during a 50-day period in leaves of chrysanthemum (Chrysanthemum morifolium Ramat. "Indianapolis White") plants grown in nutrient solution with 0, 0.01, 0.1, and 1.0 microgram/ml Cd added as CdSO4. At harvest, dry weight and Cd concentrations in roots, stems, and leaves were determined. Leaf abscission occurred on Cd-treated plants. Turgor pressures were highest in plants grown with 0.01 microgram/ml Cd and lower in plants treated with 0, 0.1, and 1.0 microgram/ml Cd. Stomatal resistances were lowest in plants grown with 0.01 microgram/ml Cd and progressively higher in plants treated with 0, 0.1, and 1.0 microgram/ml Cd. Results indicated that quantities of Cd permitted in irrigation water in the United States (0.05 microgram/ml) might be detrimental to growth because of reduced turgor pressure and increased stomatal resistance.

78:02I-032

EXTRACTABILITY OF CADMIUM, COPPER, NICKEL, AND ZINC BY DOUBLE ACID VERSUS DTPA AND PLANT CONTENT AT EXCESSIVE SOIL LEVELS,

Korcak, R.F., and Fanning, D.S.
United States Department of Agriculture, Science and Education Administration, Fruit Laboratory, Beltsville Agricultural Research Center-West, Beltsville, Maryland.
Journal of Environmental Quality, Vol. 7, No. 4, p 506-512, October-December, 1978.
1 fig, 9 tab, 18 ref.

Descriptors: Trace elements, Elements (chemical), Heavy metals, Corn (field), Sewage sludge, Correlation analysis, Cadmium, Copper, Nickel, Zinc.

Cadmium, copper, nickel, and zinc were applied as sulfate salts to samples of surface horizons of three Maryland soils in the greenhouse at rates of metals equivalent to those in 0 to 896 dry metric tons/ha of Washington, D.C., digested sewage sludge. The sludge was also applied at a rate of 224 dry metric tons/ha. Two pH regimes, approximately 5.5 and 6.5, were maintained. Metals were extracted by the DTPA (diethylenetriaminepentaacetic acid buffered at pH 7.3) or double acid (0.05N HCl, 0.025N H2SO4) extractants. Correlations were determined between extractable soil metals and metal content of two crops of corn (Zea mays L.) each grown for 30 days, but at times of 1 or 13 mo after making the chemical amendments to the soils. The results of the experiments were reported.

78:02I-033

THE UPTAKE OF 203Hg-LABELED MERCURY COMPOUNDS BY BROMEGRASS FROM IRRIGATED UNDISTURBED SOIL COLUMNS,

Hogg, T.J., Bettany, J.R., and Stewart, J.W.B.
Saskatchewan University, Saskatoon, Saskatchewan, Canada, Institute of Pedology.
Journal of Environmental Quality, Vol. 7, No. 3, p 445-450, July-September, 1978.
1 fig, 8 tab, 17 ref.

Descriptors: Mercury, Sewage effluent, Sewage disposal, Environmental effects, Bromegrass, Irrigation, Volatility, Leachate, Organic matter.

Bromegrass (Bromus inermis) was grown under conditions of sewage effluent irrigation on undisturbed soil columns in which the 0- to 10-cm layers had been treated with 10 micrograms Hg/g soil as 203Hg-labeled mercuric chloride (HgCl2), phenyl mercuric acetate (PMA), and methyl mercuric chloride (MMC). Mercury concentrations in plant dry matter decreased over three successive harvests and highest values were found on MMC-treated soils of fine texture and low organic matter content (2.0 to 0.2 micrograms Hg/g for first and third harvest, respectively). Exposure of the plants and soils to simulated fall conditions resulted in a small but significant increase in the Hg concentration of plant dry matter. Higher levels of Hg were found in plant stems than plant foliage at the termination of the experiment and even higher levels in the main roots and fine roots separated from the 0-10 cm soil layer. Mercury concentration of root decreased with depth for all Hg treatments, but were still 150 times greater than background levels in the MMC-treated soils at the 40- to 60-cm depth. A significant amount of all forms of applied Hg (10-32%) was lost during the experiment, presumably by volatilization. The majority of the remaining Hg in the soil was found to be strongly bound and not extractable by weak salt solutions, dilute acids, and chelates.

78:02I-034
CORN YIELD RESPONSES TO WATER STRESS MANAGEMENT,
Stegman, E.C., and Aflatouni, M.
North Dakota State University, Fargo, Department of Agricultural Engineering.
Paper No. 78-2558, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 9 p. 8 fig, 3 tab, 18 ref, 1 equ.

Descriptors: Moisture stress, Evapotranspiration, Crop response, Corn (field), Moisture deficit, Growth stages, Irrigation, Water management (applied), Water requirements, Irrigation systems.

Relative yield (Y/Ymax) vs. relative evapotranspiration (ET/ETmax) functions were defined for major growth periods. These functions also suggested some yield loss may occur due to water stress before an ET depression necessarily also occurs. Relative yield attainment was also related to minimum levels of leaf xylem pressure just prior to stress relief in given growth stages.

78:02I-035
PREDICTING YIELDS,
Haun, J.R.
Clemson University, South Carolina, Department of Horticulture.
Crops and Soils Magazine, Vol. 31, No. 2, p 7-9, November, 1978. 3 fig.

Descriptors: Crop production, Crop response, Climatic data, Weather data, Plant growth.

This paper presents a new concept in the evaluation of plant-environment relations for developing yield prediction systems. This approach involves the daily measurement of plant response in the field under natural, uncontrolled variations in weather conditions. These plant growth data, with associated weather variables, are to be analyzed by computer to develop the yield prediction system.

78:02I-036
SOYBEAN CROP WATER REQUIREMENTS,
Dominguez, J., Horta, M., and Robledo, E.
Regional Center of Agricultural Research No. 06, CRIDA 06, Spain, Department of Cereals and Legumes.
ICID Bulletin, Vol. 27, No. 2, p 30-35, July, 1978. 3 fig, 22 ref.

Descriptors: Soil-water-plant relationships, Water requirements, Soybeans, Moisture deficit, Moisture stress, Growth stages, Water management (applied), Evapotranspiration, Yield equations, Crop production.

In experiments carried out in the three-year period 1974-1976, in "Finca El Encin", CRIDA 06, Alcala de Henares, on soybean crops irrigated by sprinklers, Amsoy variety, a very high correlation between the RET (Real Evapotranspiration) in the flowering and pod formation period and the final grain production was found. This suggested, on the one hand, subjecting the plant to an initial deficit to adequately develop the root system and on the other, supplying quantities of about 9 mm during the said period, which should increase the production level to 4,000 kg/hectare. Penman's modified formula for daily application, following the guidelines of the Irrigation Management Service, proved to be inadequate in the sense that it provided low ETP values. A greater consideration of the aerodynamic term was suggested by the influence that the advective effect has on irrigation areas with arid climates. For practical experiments the scheme proposed in the DWR-UCD Meeting 1975 based on the utilization of the distribution curves of a water sprinkler, was proved satisfactory, leading to a more reliable analysis, and to a simplification of the experimental procedure.

78:02I-037
WATER BALANCE OF FLOODED RICE PADDIES,
Brown, K.W., Turner, F.T., Thomas, J.C., Deuel, L.E., and Keener, M.E.
Texas A & M University, College Station, Department of Soil and Crop Sciences.
Agricultural Water Management, Vol. 1, No. 3, p 277-291, November, 1978. 10 fig, 3 tab, 8 ref.

Descriptors: Water balance, Submerged plants, Flood irrigation, Rice, Water management (applied), Water requirements, Evapotranspiration, Runoff.

Rice (Oryza sativa L., var. Labelle) was grown in 300 m^2 paddies of Beaumont clay soil (Typic pelludert) and subjected to two management schemes of flooded rice culture. These schemes were continuous irrigation and intermittent irrigation. Careful measurements of irrigation, precipitation, evapotranspiration, deep percolation and runoff were made, and the total water balance for the two water management schemes was calculated. The results showed continuous irrigation to be very wasteful of water with slightly over 1 m of irrigation water applied to supply an evapotranspirational need of 0.5--0.6 m. The intermittent irrigation management was less wasteful but still could be improved upon. Suggestions were presented for techniques to help improve the water use efficiency and reduce runoff losses.

78:02I-038
SEASONAL WATER USE BY WINTER WHEAT GROWN UNDER SHALLOW WATER TABLE CONDITIONS,
Saini, B.C., and Ghildyal, B.P.
G.B. Pant University of Agriculture and Technology, Pantnagar, Distr. Nainital, India.
Agricultural Water Management, Vol. 1, No. 3, p 263-276, November, 1978. 10 fig, 1 tab, 27 ref.
(See 78:02G-076)

78:02I-039
LEAF OSMOTIC POTENTIAL AS AN INDICATOR OF CROP WATER DEFICIT AND IRRIGATION NEED IN RAPESEED (BRASSICA NAPUS L.),
Clarke, J.M., and Simpson, G.M.
Research Station, Research Branch, Agriculture Canada, Swift Current, Saskatchewan S9H 3X2, Canada.
Agricultural Water Management, Vol. 1, No. 4, p 351-356, December, 1978. 2 fig, 3 tab, 8 ref.

Descriptors: Moisture deficit, Moisture content, Water requirements, Moisture stress, Moisture tension, Leaves, Scheduling, Tensiometers, Osmotic pressure, Crop production.

Leaf osmotic potentials (LOP) of field-grown rapeseed (Brassica napus L.) were measured in 1975 and 1976 under rainfed conditions and at two levels of irrigation. Irrigations were scheduled on the basis of tensiometer measurements in 1975, and on the basis of LOP in 1976. The LOP of rainfed plants was lower (more negative) than that of irrigated plants. Leaf osmotic potential responded to changes in soil moisture caused by precipitation or irrigation. Tensiometers placed at 0.2 m depth in the high irrigation treatment were as responsive to soil moisture changes as LOP. Scheduling of irrigations on the basis of LOP in 1976 produced yield differences between water regimes similar to those obtained in 1975. It was concluded that leaf osmotic potential provides a satisfactory means for determining need for irrigation in B. napus.

78:02I-040
RESPONSE TO CORN TO LIMITED IRRIGATION ON SANDY SOILS,
Wilson, G.D., Watts, D.G., and Fischbach, P.E.
Nebraska University, North Platte, Department of Agricultural Engineering.
Paper No. 78-2554, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 11 p. 6 fig, 5 tab, 3 ref, 1 equ, 3 append.

Descriptors: Irrigation, Moisture deficit, Irrigation effects, Water management (applied), Growth stages, Plant populations, Yield equations, Corn (field), Water requirements, Crop production.

The objective of this experiment was to provide information for producers to enable them to make sound decisions concerning irrigation management when water is limited. Five irrigation management systems were evaluated on a Valentine very fine sand (Typic Ustipsamment) in North Central Nebraska in 1977 and 1978. Two management systems included limited irrigation. The latter were subdivided into three treatments each in 1977 providing a total of six discrete limited irrigation treatments.

Another treatment was added in 1978 making a total of seven limited irrigation treatments. In each year, the limited irrigation treatments were compared to nonirrigated and fully irrigated checks. Significant water savings were achieved with the limited irrigation treatments. Yield variation from full irrigation yields ranged from 4750 kg/ha reductions to 900 kg/ha increases. As much as 12.2 cm of irrigation water were saved with no yield reduction, even though water use was reduced. Irrigation response ratio was defined as the yield increase over the nonirrigated crop per unit of water applied. It was presented as a management tool and was significantly affected by limited irrigation.

78:02I-041
EVALUATION OF CROP WATER STRESS UNDER LIMITED IRRIGATION,
Heermann, D., and Duke, H.
Agricultural Research, Science and Education Administration, Fort Collins, Colorado, United States Department of Agriculture.
Paper No. 78-2556, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 5 p. 8 fig, 8 ref.

Descriptors: Moisture stress, Moisture deficit, Sprinkler irrigation, Soil moisture, Yield equations, Corn (field), Growth stages, Water requirements.

Limited water application plots were established under 2 center pivot systems planted to corn. Stress was quantified by measuring water applied, soil water, canopy temperatures and plant water potentials. Yield reductions were linearly related to applied water and average canopy temperature differences between control and stressed plots.

78:02I-042
IRRIGATED CORN YIELD RESPONSE TO WATER,
Musick, J.T., and Dusek, D.A.
Southwestern Great Plains Research Center, Bushland, Texas, United States Department of Agriculture.
Paper No. 78-2557, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 26 p. 8 fig, 3 tab, 16 ref.

Descriptors: Irrigation, Crop response, Moisture deficit, Evapotranspiration, Moisture stress, Corn (field), Water requirements, Yield equations, Growth stages, Water management (applied).

Corn grain yield response to water deficits and seasonal evapotranspiration-yield relationships were determined during a 3-yr study in the Southern High Plains. Sensitivity of yields and water-use efficiencies to plant-water stress indicated that limited irrigation should not be practiced in the high-evaporative demand climate.

78:02I-043
MAGNESIUM UPTAKE FROM EXCHANGEABLE AND NONEXCHANGEABLE SOURCES IN SOILS AS MEASURED BY INTENSIVE CROPPING,
Christenson, D.R., and Doll, E.C.
Michigan State University, East Lansing, Department of Crop and Soil Sciences.
Soil Science, Vol. 126, No. 3, p 166-168, September, 1978. 4 tab, 6 ref.

Descriptors: Magnesium, Nutrients, Minerology, Greenhouses, Nutrient removal, Oats, Michigan, Plant growth.

Several soils were cropped with four consecutive crops of oats (Avena sativa, "Garry") in the greenhouse. Changes in exchangeable Mg levels were used to indicate uptake from that source. The remainder of the uptake was attributed to the nonexchangeable source. Total uptake by the four crops did not appear to be related to total Mg level in the soil, percent clay in the soil, or exchangeable Mg level. Mg availability did appear to be related to the mineralogy of the medium clay fraction.

SECTION X

WATER CYCLE

EROSION AND SEDIMENTATION (GROUP 02J)

78:02J-001
A SIMPLE LABORATORY APPARATUS TO MEASURE RELATIVE ERODIBILITY OF SOILS,
Chandra, S., and De, S.K.
Allahabad University, India.
Soil Science, Vol. 125, No. 2, p 115-121, February, 1978. 3 fig, 3 tab, 18 ref.

Descriptors: *Erosion rates, *Measurement, *Erosion, *Erodibility, Soils, Laboratory equipment, Laboratory tests, Clays, Soil conservation, Instrumentation.

A simple laboratory apparatus designed for rapid and inexpensive measurement of the relative erodibility of soils was described. Erosion coefficients obtained with this apparatus were correlated with other erosion indices, viz., erosion ratio, clay ratio, and silica:sesquioxide ratio, and were found to be in good agreement. This apparatus can be used where routine analysis is required of a large number of soil samples for their relative erodibility by water.

78:02J-002
EROSION RATES OF COHESIVE SOILS,
Ariathurai, R., and Arulanandan, K.
Nielsen Engineering and Research, Incorporated, Mountain View, California.
Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers, Vol. 104, No. HY2, Technical Notes, p 279-283, February, 1978. 5 fig, 4 ref, 1 append.

Descriptors: *Erosion rates, *Cohesive soils, *Laboratory tests, Erosion, Soils, Shear stress, Clays, Soil types, Cation exchange, Loam, Illitie, Temperature, Chemical properties, Mechanical properties, Expansive soils, Testing procedures, Yolo loam, Sodium adsorption ratio.

The objective was to describe the effects of the principal physical and chemical factors on the rate of erosion of saturated cohesive soils. A number of remolded samples with different types and amounts of clay and different pore fluid compositions were preconsolidated in a 7.6-cm diam cylindrical tube at a normal stress of 1 kg/sq cm. After consolidation, the samples were placed in the eroding fluid to be used and were allowed to swell for a few hours. The results of erosion tests on over 200 natural and made-up soil samples indicated that the erosion rate constant M lies in the range 0.003 g/sq cm x min to 0.03 g/sq cm x min with few exceptions. The slopes of the erosion rate curves increases with increase in critical shear stress. If the relationship between s and critical shear stress were inverse, then M would be independent of the critical shear stress, although N may vary with other chemical and physical parameters. If further measurements designed to investigate the relationship between the erodibility constants critical shear stress and M should yield a functional relationship between the two, there will be one less parameter to deal with in problems such as the determination of soil yield from watersheds, and estuarial sediment transport.

78:02J-003
PHYSICAL, CHEMICAL, AND MINERALOGICAL PROPERTIES OF FLUVIAL UNCONSOLIDATED BOTTOM SEDIMENTS IN NORTHWESTERN OHIO,
Wall, G.J., Wilding, L.P., and Smeck, N.E.
Guelph University, Ontario, Canada N1G 2W1, Agricultural Canada.
Journal of Environmental Quality, Vol. 7, No. 3, p 319-325, July-September, 1978. 5 fig, 5 tab, 16 ref.

Descriptors: Fluvial sediments, Unconsolidated sediments, Chemical properties, Physical properties, Minerology, Water pollution, Water quality, Heavy metals, Sediment load, Suspended load.

Fluvial unconsolidated bottom sediments that have the potential to become part of the suspended sediment load in the Maumee River Basin, Ohio, ranged in texture from sandy loams to clays. The water-dispersible clay was lower in mica but higher in expandable 14 A (smectite) and quartz constituents than the electrolyte-dispersible clay. The mineralogy of clay-sized bottom sediments from upstream agricultural drainage ditches, major Basin tributaries, and from the Maumee River were found to be essentially identical. The 2- to 50-microns fraction was dominated by quartz with secondary amounts of mico, kaolinite, feldspars, and carbonates. Mean calcite, dolomite, and calcium carbonate equivalent values were 4.1, 3.4, and 7.8%, respectively. Organic matter content of the fluvial bottom sediments (3 to 7%) was analogous to Lake Erie bottom sediments and Maumee River suspended sediments. CEC values ranged from 39 to 55 meq/100 g for the total clay fraction. Enrichment of heavy metals of bottom sediments over surficial soil materials occurred for Cu, Ni, Zn, Ca, and Pb by factors of 1.6, 2.0, 2.3, 3.5, and 3.0, respectively. Traces of herbicides and insecticides were detected in the filtered stream water samples and bottom sediment materials. Downstream trends in selected physical, chemical, and mineralogical properties could not be related to increased urban influences or increased stream discharge.

78:02J-004
UNIT SEDIMENT GRAPH,
Rendon-Herrero, O.
Mississippi State University, Starkville, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 889-901, October, 1978. 12 fig, 3 tab, 23 ref, 3 equ.

Descriptors: Sediment discharge, Suspended load, Unit hydrographs, Graphical analysis, Graphical methods, Small watersheds, Surface runoff, Soil erosion, Precipitation (atmospheric).

The unit hydrograph method was extended to sediment graph analysis, thus yielding a unit sediment graph. The method is applicable to small uniform watersheds where the main contribution to suspended sediment transported in the drainage channels as the result of runoff derives from upslope erosion, that is, from wash load and not from entrained bed load material. Bixler Run, a small wash load-producing watershed near Loysville, Pennsylvania, was used as a data source in deriving unit sediment graphs. The hydrographs and concomitant sediment graphs used were generally parallel in shape and coincided during peak flow.

78:02J-005
DEPOSITION OF NONUNIFORM SEDIMENT ON CONCAVE SLOPES,
Davis, S.S., Foster, G.R., and Huggins, L.F.
Purdue University, Lafayette, Indiana, Department of Agricultural Engineering.
Paper No. 78-2519, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 19 p. 8 fig, 4 tab, 20 ref, 3 equ.

Descriptors: Sediment transport, Simulation analysis, Overland flow, Aggregates, Sands, Sediment yield, Homogeneity, Heterogeneity, Slopes, Watersheds (basins).

A laboratory study was conducted to investigate behavior of simulated natural sediments transported and deposited by overland flow. Aggregate substitutes and sand were studied both as separate homogeneous sediments and as weight proportionally combined heterogeneous sediment mixtures.

78:02J-006
DESIGN AND OPERATION OF GRADIENT TERRACE SYSTEMS,
Bondurant, D.T., and Laflen, J.M.
Soil Conservation Service, Des Moines, Iowa.
Paper No. 78-2520, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 7 p. 4 fig, 5 tab, 19 ref.

Descriptors: Terracing, Erosion control, Pollution abatement, Design criteria, Costs, Water quality, Graded, Soil conservation, Water conservation, Sediment control.

Two types of gradient terraces were planned on each of two Iowa fields. Comparison shows that the type of terrace selected will have a major effect on cost of terracing and on farmer acceptance, but little effect on off-field water quality.

78:02J-007
EXCAVATED SEDIMENT TRAPS--WHAT RALPH WALDO EMERSON WAS REALLY TALKING ABOUT,
Tryon, C.P., Parsons, B.L., and Miller, M.R.
Mark Twain National Forest, Rolla, Missouri.
Paper No. 78-2089, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 10 p. 9 ref.

Descriptors: Sediment control, Sediments, Sediment load, Soil erosion, Detention reservoirs, Erosion, Cost comparisons, Comparative costs, Missouri.

A decade of experience on large earth moving jobs in the Missouri Ozarks has shown that excavated sediment traps are incomparably superior to small detention dams in terms of cost, industry acceptance, and sediment trap efficiency.

78:02J-008
REDUCING STREAM SEDIMENT LOADS BY IRRIGATION DIVERSIONS,
Johnson, C.W., and Smith, J.P.
Northwest Watershed Research Center, Boise, Idaho.
Paper No. 78-2088, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 14 p. 4 fig, 4 tab, 11 ref.

Descriptors: Sediment control, Sediment load, Sediment discharge, Soil erosion, Sediments, Streamflow, Diversion, Diversion structures, Irrigation, Idaho.

A streamflow, irrigation diversion, and suspended sediment study on the Reynolds Creek Experimental Watershed in southwest Idaho shows the effectiveness of an irrigation system in reducing downstream sediment loads. About 560 tonnes of sediment per year was deposited on 690 ha of pasture, hay, and grain cropland, an average deposition of 0.08 mm per year. The sediment from natural streamflow is usually beneficial to crop production in this mountain valley.

78:02J-009
THE DESIGN OF SEDIMENT BASINS,
Ward, A.D., Haan, C.T., and Barfield, B.J.
Kentucky University, Lexington, Department of Agricultural Engineering.
Paper No. 78-2086, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 32 p. 4 fig, 4 tab, 17 ref, 15 equ.

Descriptors: Sediment control, Sediments, Detention reservoirs, Design, Mining, Mine wastes, Hydrologic aspects, Regression analysis, Simulation analysis, Computer programs.

Passage of Public Law 95-87 has placed several new restrictions on the design of surface mine sediment basins. It created much controversy as to the required sizing of the sediment basins, and adequate design methods are not available for estimating basin performance and effluent sediment concentrations. This paper presents guidelines as to how the hydrologic parameters affecting sediment basin design may be quantified and contains predictive equations for estimating basin trap efficiency and peak effluent sediment concentrations. Multiple regression analysis techniques were employed with data generated by a hydrograph computer program and by a simulation model. The simulation model has been tested on several actual basins and appears to give a good estimate of basin performance. It also gave a good estimate of the performance of Callahan Reservoir during a 60-day period in 1973. A new version of the model allows for variation in the particle size distribution with runoff rate, and in this paper criteria are presented which account for basins with a permanent pool and also considers base flow conditions following a design storm event.

78:02J-010
SEDROUTE PROCEDURE FOR ESTIMATING EROSION AND SEDIMENT IMPACTS,
Kelly, G.D.
Manti-LaSal National Forest, Price, Utah.
Paper No. 78-2081, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 7 p. 4 ref, 3 equ.

Descriptors: Sediment yield, Surface runoff, Runoff, Sediments, Model studies, Sediment load, Data processing, Mining, Sediment control, Idaho.

The SEDROUTE procedure predicts the amount and charge in erosion and sediment yield that will occur from a proposed project. The model uses a minimum of data and responds to changing project details. Impacts are routed downstream to show the effects of other water and sediment sources.

78:02J-011
SEA RESEARCH PROGRAM FOR CHANNEL STABILITY AND GULLY CONTROL,
Little, W.C., Piest, R.F., and Robinson, A.R.
Paper No. 78-2080, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p. 13 ref.

Descriptors: Channel erosion, Channel improvement, Stability, Gullies, Gully erosion, Stream erosion, Stabilization, Research and development, Environmental effects.

There are a multitude of factors relating to problems of unstable channels and active gullies. There are limited methods of control and additional cost effective methods are required. The potential for improved technology is great. The USDA, Science and Education Administration, Federal Research Program is conducting research on stabilization of stream channels and control of gullies.

78:02J-012
EROSION SIMULATION FOR LAND USE MANAGEMENT,
DeCoursey, D.G.
Sedimentation Laboratory, Oxford, Mississippi, U.S. Department of Agriculture.
Paper No. 78-2082, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p. 6 fig, 8 tab.

Descriptors: Soil erosion, Erosion, Simulation analysis, Runoff, Surface runoff, Sediment yield, Hydrographs, Land management, Land use, Cotton.

In May, 1976, a paper entitled "Philosophy of Erosion Simulation for Land Use Management" by D.G. DeCoursey and L.D. Meyer was presented at a Soil Erosion Workshop at Purdue University. The paper described schematically, a concept for combining hydrology, infiltration, moisture redistribution, crop growth, and rill-interrill erosion models to produce a dynamic simulation system that can be assembled to evaluate the environmental impact of land management alternatives. Most of the parameters are based on measurable factors or field tests. This paper describes such a simulation system and the data necessary to use it. Data from a cotton field in the Mississippi Delta were used to test and refine the system. Examples showing how the system can be used to evaluate alternative land management schemes are presented. Output from the system includes runoff, sediment, and cotton production. They were used to show how factors such as plant population fertilizer, row spacing, land slope and tillage operations can affect management alternatives.

78:02J-013
TOTAL LOAD OF BED MATERIALS IN OPEN CHANNELS,
Kikkawa, H., and Ishikawa, T.
Tokyo Institute of Technology, Japan, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY7, Proceedings Paper 13895, p 1045-1059, July, 1978. 10 fig, 12 ref, 2 append.

Descriptors: *Bed load, *Open channels, *Model studies, *Stochastic models, Channel flow, Sediment transport, Stochastic processes, Suspended load, Hydraulics, Sedimentation, Equations, Mathematical models, Bed material load, Sediment sources, Synthetic models.

Bed material load usually is classified into bed load and suspended load. They have been treated individually in the previous theoretical studies, but to obtain the expression of total load, their mutual relation must be formulated. The main objective in this investigation was to study this relation. The basic consideration was that the bed layer is formed under the balance of vertical forces acting on sediment particles near and on the bed surface and this layer can be regarded as the source of sediments to be diffused to the region of suspended load. According to this consideration: (1) a new stochastic model that interrelates bed load and suspended load was considered to simulate the particle movement; and (2) the equation of dynamic balance in the bed layer was introduced and improved by using the results of basic experiments. A total load equation was derived by combining the results of two processes. The data presented by U.S.G.S. were used to verify it.

78:02J-014
DIFFUSION OF SEDIMENT IN LONG CHANNELS,
Aronsson, G.
Uppsala University, Sweden, Department of Mathematics.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY6, Proceedings Paper 13845, p 821-837, June, 1978. 7 fig, 12 ref, 1 append.

Descriptors: *Dispersion, *Diffusion, *Sediments, *Model studies, *Long channels, Mathematical models, Distribution, Distribution patterns, Sediment distribution, Spatial distribution, Channels, Turbulence, Sediment transport, Sedimentation, Mathematics.

A model was presented, treating the transport of suspended material in a broad channel under simplifying assumptions. The motion of sediment was treated as a diffusion process, and a differential equation was derived. The form of an "equilibrium distribution" g(y) was derived, corresponding to the classical distribution of Prandtl and Rouse. Mathematically the following two results were proven: (1) if a stationary (time dependent) state prevails downstream at a certain point P, then the distribution downstream P tends (with increasing distance to P) exponentially to the "equilibrium distribution"; and (2) if the sediment distribution in the incoming downstream P will tend to the stationary solution exponentially with time. Although these results seem to be physically evident, they apparently have not been proven before.

78:02J-015
EROSION CONTROL/SEDIMENT MODELING--SOUTHERN IDAHO A PROGRESS REPORT,
Longley, T.S.
Idaho University, Aberdeen, Research and Extension Center.
Paper No. 78-2028, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 6 p. 3 fig, 4 ref, 12 equ.

Descriptors: Soil erosion, Erosion, Agricultural watersheds, Sediments, Sediment load, Return flow, Idaho, Irrigation, Water quality, Model studies.

The progress of erosion control/sediment modeling was reported. The modeling effort proceeded in three steps: (1) the furrow erosion submodel, (2) the instream erosion control practice submodel, and (3) the routing method to route the water down through the watershed. The furrow erosion submodel predicts the sediment lost from an individual field using furrow hydraulic parameters and the stream power concept explained below. The instream erosion control practice submodel predicts the effectiveness of the best management practices in cleaning the sediment from the return flow, and finally a routing procedure is used to move the flow and associated sediment through the watershed.

78:02J-016
SCOUR OF BED MATERIAL IN VERY ROUGH CHANNELS,
Bayazit, M.
Technical University, Istanbul, Turkey, Department of Hydraulics and Water Power.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY9, p 1345-1349, September, 1978. 3 fig, 2 ref, 4 equ, 1 append.

Descriptors: Scour, Open channel flow, Roughness (hydraulic), Beds, Velocity, Flow characteristics, Vibrations.

In this paper an attempt was made to explain the relative roughness effect on the scour of bed material in shallow depths on the basis of flow characteristics observed in a previous study (Bayazit, J. of Hydraulic Res., 14(2), 1976). Experiments with densely packed uniform spheres confirmed that the initiation of motion of bed material is affected by the relative roughness of the channel. At shallow depths, larger values of the Shields' parameter are required to initiate the motion. This was explained by the reduction of nondimensional velocities at the bed level with the increase of relative roughness. The effective value of the instantaneous flow velocity was thus achieved at higher bed shear stresses in comparison with flows at mild slopes.

78:02J-017
NUMERICAL STUDY OF CONTINUOUS SALTATION,
Reizes, J.A.
New South Wales University, Sydney, Australia, School of Mechanical and Industrial Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY9, p 1305-1321, September, 1978. 12 fig, 15 ref, 31 equ, 3 append.

Descriptors: Saltation, Sediment transport, Numerical analysis, Mathematical models, Computer programs, Bed load, Simulation analysis, Drag.

This paper reported a theoretical study of a particle in continuous saltation involving a numerical solution of the three-dimensional equations of particle motion including collision with the bed. Some of the difficulties and inaccuracies associated with an experimental evaluation of bed load were avoided by the use of a computer simulation of a saltating particle. Continuous saltation was possible as the result of the proposed three-dimensional bed-particle interactions, even in the absence of vertical fluid velocity components and lift forces. Comparison with experimental data suggested that the model is at least a reasonable representation of the process. It was shown that for an isolated particle near the bed, an apparent lift force, which can be greater than the gravitational force, results from the nonlinear drag force. It was also shown in this study that previously attempted single parameter correlations are inadequate and that at least two parameters are required to collapse the numerical results into an orderly array of curves. The Shields entrainment function and the particle Reynolds number were modified to obtain two parameter correlations.

78:02J-018
TRANSPORT OF A NONCOHESIVE SANDY MIXTURE IN RAINFALL AND RUNOFF EXPERIMENTS,
Walker, P.H., Kinnell, P.I.A., and Green, P.
Sediment Transport Group, Division of Soils, Box 639, P.O. Canberra City, A.C.T. 2601, Australia.
Soil Science Society of America Journal, Vol. 42, No. 5, p 793-801, September-October, 1978. 8 fig, 3 tab, 20 ref, 4 equ.

Descriptors: Raindrops, Runoff, Surface runoff, Suspension, Rainfall intensity, Bed load, Suspended load, Overland flow, Soil erosion.

Rainfall intensities of 45, 100, and 150 mm/hr with systematically varied kinetic energies were applied to a saturated noncohesive, sandy bed 3 m long and set at slopes of 0.5 and 5%. Detailed size analyses of solids discharged showed that the <31 micron fraction was most readily mobilized and behaved as a suspended load; and 31- to 250-micron fraction was transported slowly, much apparently as saltating bed load; the 0.25- to 4-mm fraction was transported rapidly, grains tending to move as rolling bed load; the >4 mm fraction behaved as a lag gravel. The sedimentary properties of bed deposits also reflected the differentiation of various size fractions and minerals in the original mixture. The effects of raindrop impacts within the flow were more important in promoting transport of solids than the aerial component of splash. Under conditions where overland flow had developed, transport of solids was related directly to rainfall intensity and variations in rainfall energy that were associated with variations in raindrop impact frequency. Increases in rainfall energy due to increasing raindrop sizes did not result in increases in solids discharged.

78:02J-019
SUBSURFACE DRAINAGE MODEL WITH ASSOCIATED SEDIMENT TRANSPORT,
Bottcher, A.B., Monke, E.J., and Huggins, L.F.
Florida University, Gainesville.
Paper No. 78-2502, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 21 p. 4 fig, 15 ref, 18 equ.

Descriptors: Subsurface drainage, Model studies, Computer models, Sediment transport, Simulation analysis, Tile drainage, Water yield, Sediment yield, Flow rates, Hydraulic conductivity.

A computer model was developed, using the GASP IV simulation language to simulate the water flow and sediment movement from a subsurface drainage system. The model uses a one dimensional form of the Richard's Equation and a steady state tile flow formula by Toskoz and Kirkham to express the water movement process. The particle detachment model, which is based on a force balance relationship, is driven directly by the output of the flow model. Data required by the model includes rainfall, evapotranspiration, soil properties, and the drainage system layout. Calibration and verification was completed using data collected from a seventeen hectare tile drainage system located on a flat Hoytville silty clay soil. A comparison of the simulated and observed results indicate that the model will reliably predict water yield, sediment yield and the sediment concentration curve. The model had difficulty in simulating the actual shape of the flow hydrograph.

78:02J-020
FARM LEVEL ECONOMIC EVALUATION OF EROSION CONTROL,
McGrann, J.M.
Iowa State University, Ames.
Paper No. 78-2515, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 2 fig, 3 tab, 15 ref.

Descriptors: Erosion control, Soil erosion, Cost comparisons, Soil management, Economic feasibility, Water pollution, Economic impact, Contour farming.

Farm level economic evaluation of erosion control alternatives in three major soil associations in Iowa indicated that: (1) residue tillage and contouring is the most cost effective alternative to reduce soil erosion, (2) the economic impact of reducing soil loss is less on mixed crop and livestock farms than specialized crop farms, and (3) although the economic impact of erosion control differs between soil areas, reduction of soil loss below the 5 ton level can be accomplished through conservation tillage in large areas of Iowa with little reduction in farm income without public participation in farm level costs.

78:02J-021
EROSION INVENTORY-SHEET AND RILL EROSION,
Dideriksen, R.I., and Hidlebaugh, A.R.
Soil Conservation Service, Washington, District of Columbia.
Paper No. 78-2514, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 33 p. 3 fig, 14 tab, 13 ref.

Descriptors: Erosion, Soil erosion, Rill erosion, Sheet erosion, Wind erosion, Erosion control, Data collections, Conservation.

Erosion by wind and water from farmland remains a serious problem in the United States. This inventory takes a new look at the problem and provides current information on natural and related resources on nonfederal land for all states except Alaska. Nearly one quarter million randomly selected sample sites were observed in the field and farm owners and operators were interviewed. The data gathered in 1977 were used in the Universal Soil Loss and Wind Erosion models to estimate the rate and amount of sheet, rill, and wind erosion for different soils, land uses, and management systems.

78:02J-022
EVALUATION OF GRASS CHARACTERISTICS RELATED TO SEDIMENT FILTRATION,
Hayes, J.C., Barfield, B.J., and Barnhisel, R.I.
Kentucky University, Lexington, Department of Agricultural Engineering.
Paper No. 78-2513, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 21 p. 7 fig, 2 tab, 10 ref.

Descriptors: Sediment transport, Sediment control, Filtration, Grasses, Vegetation effects, Sediment yield, Water pollution, Regression analysis, Roughness coefficient, Watershed management.

Vegetal filtration was proposed as a means of reducing sediment from disturbed areas. Recent studies using simulated media have led to relationships which define deposition within a grass filter. Several characteristic dimensions were required to define the effects of vegetation on flow and sediment transport. Quantification of these dimensions, sensitivity of the relations to errors in measurement, and further verification data was included in the paper.

78:02J-023
NITROGEN AND PHOSPHORUS LOSSES IN RUNOFF FROM NO-TILL SOYBEANS,
McDowell, L.L., Ryan, M.E., McGregor, K.C., and Greer, J.D.
Sedimentation Laboratory, Oxford, Mississippi, United States Department of Agriculture.
Paper No. 78-2508, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 8 p. 10 fig, 4 tab, 18 ref.
(See 78:05G-043)

78:02J-024
A FINITE ELEMENT HYDROLOGIC MODEL TO DETERMINE THE EFFECT OF LAND MANAGEMENT PRACTICES ON EROSION AND SEDIMENTATION IN A WATERSHED,
Ross, B.B., Shanholtz, V.O., and Contractor, D.N.
Virginia Polytechnic Institute and State University, Blacksburg, Department of Civil Engineering.
Paper No. 78-2507, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 42 p. 11 fig, 7 tab, 41 ref, 12 equ.

Descriptors: Soil erosion, Sedimentation, Sediment transport, Erosion, Land management, Flood routing, Finite element analysis, Water quality, Simulation analysis, Model studies.

The use of a finite element flood routing model for simulating erosion and sediment transport was proposed. A conceptual framework was provided whereby detailed spatiotemporal variations in such factors as soils, landuse topography and rainfall can be integrated to predict water quantity and quality to determine the effect of various landuse management practices on erosion and sediment transport.

78:02J-025
SEDIMENT SIZES ERODED FROM ROWCROP SIDESLOPES,
Meyer, L.D., Harmon, W.C., and McDowell, L.L.
Sedimentation Laboratory, Oxford, Mississippi, United States Department of Agriculture.
Paper No. 78-2518, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 9 p. 7 fig, 4 tab, 13 ref.

Descriptors: Sediments, Sediment distribution, Simulated rainfall, Soil erosion, Size, Rainfall intensity, Canopy.

Row sideslopes of ten soils were studied under simulated rainstorms to determine the size distributions of their eroded (undispersed) sediment. The eroded sediment sizes for different soils differed considerably. These distributions were compared to the size distributions of the dispersed sediment and original surface soil. The undispersed sediment was coarser than the dispersed soil or sediment much coarser for many soils. For each soil, the sediment size distribution changed relatively little with major changes in rain intensity, continued erosion, and crop canopy.

78:02J-026
EROSION DEPOSITS IN TILE-DRAINS,
Paterson, E., and Mitchell, B.D.
The Macaulay Institute for Soil Research, Braigiebuckler, Aberdeen AB9 2QJ, Great Britian.
Agricultural Water Management, Vol. 1, No. 4, p 311-317, December, 1978. 2 fig, 1 tab, 6 ref.

Descriptors: Tile drains, Tile drainage, Silting, Deposition (sediments), Soil erosion, Sedimentation, Drainage.

The mechanism of silting up of tile field drains in two heavy textured surface water gley soils was examined by comparing the physical and mineralogical characteristics of deposits in drains with those of the clay soil directly above. The deposits consisted of clay, silt and sand and are distinctly laminated. They appeared to be the result of internal erosion of the soil. The processes operative seemed to have been: (a) inflow of soil through the drain joints; (b) sedimentation in the drain; (c) elution of very fine material. The possibility that this silting-up phenomenon is not uncommon in the tile field drains of surface water gley soils of Scotland was recognized.

78:02J-027
SIZE DISTRIBUTION OF ERODED MATERIAL FROM SIMULATED RAINFALL: EFFECT OVER A RANGE OF TEXTURE,
Gabriels, D., and Moldenhauer, W.C.
State University, Ghent, Belgium, Department of Agricultural Sciences.
Soil Science Society of America Journal, Vol. 42, No. 6, p 954-958, November-December, 1978. 1 fig, 4 tab, 16 ref.

Descriptors: Soil erosion, Erosion, Surface sealing, Particle size, Runoff, Simulated rainfall, Soil texture, Soil aggregates, Water pollution.

This study reported size distributions and composition of material detached by water drops and transported in shallow flow. The size distributions of aggregates and primary particles in the splashed, washed, and seal material at different times during a laboratory simulated rainfall were compared for different textured soils. The wash had more finer material than did the splash. The wash and splash material at equilibrium were not different from the original soil, while the seal of all soils had a larger silt content than the original soils. The silt loam soil had seals with about the same clay content as the original soil, while silty clay soils had seals with less clay than the original soils. Of significance from this study was the low percentage of dispersed clay being eroded compared to the percent of clay in the original soil and that this percentage didn't change significantly with time. The most striking differences were between soils and these were influenced mainly by texture and aggregate condition of the original soils.

78:02J-028
SEDIMENT TRAPS IN CHANNELS--DESIGN PROCEDURES AND PERFORMANCE,
Konwinski, G.R.
Soil Conservation Service, East Lansing, Michigan.
Paper No. 78-2561, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 6 p. 2 fig.

Descriptors: Sediment control, Stream erosion, Channel erosion, Stream stabilization, Trap efficiency, Bed load, Energy dissipation, Channel flow, Design data.

The design and maintenance of sediment traps to control a stream's energy play a key role in ensuring uniform cross-sectional area in trapezoidal channels. It was suggested that the bedload and the upland must be carefully analyzed to determine the critical energy level which is the first step in the design of a successful in-channel sediment trap. The procedure provided design data needed to proportionate the sediment trap to trap bedload sediments by reducing flow velocity through trap.

SECTION XI

WATER CYCLE

CHEMICAL PROCESSES (GROUP 02K)

78:02K-001
UTILIZATION OF LABELLED UREA AND AMMONIUM SULFATE BY LOWLAND RICE,
Reddy, K.R., Patrick, W.H., Jr.
Louisiana State University, Baton Rouge, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 465-467, May-June, 1978. 4 tab, 4 ref.

Descriptors: Stable isotopes, Ureas, Ammonium compounds, Nitrogen, Fertilizers, Fertilization, Rice, Flood irrigation.

The objective of this investigation was to compare labelled ammonium sulfate and urea in their effect on yield and N utilization in field microplots on Crowley silt loam (typic albaqualf). Nitrogen was applied as an early season topdressing or as a midseason topdressing and the grain and straw yield and recovery of labelled and native N in the grain straw, and soil were measured. No significant differences in grain and straw yields were observed for the two sources and two times of N application. Ammonium sulfate and urea did not differ significantly in N utilization by the crop. For both sources the recovery of labelled N in the soil-plant system was highest (34 to 55 kg N/ha) in the plots receiving early season topdressing (30 to 38 kg N/ha). More native soil N was taken up by the plants during 1976 as compared to the 1975 season.

78:02K-002
DETERMINATION OF STABILITY CONSTANTS OF METAL-HUMIC ACID COMPLEXES BY POTENTIOMETRIC TITRATION AND ION-SELECTIVE ELECTRODES,
Takamatsu, T., and Yoshida, T.
National Institute for Environmental Studies, Yatabe-cho, Ibaraki, Japan, Water and Soil Environment Division.
Soil Science, Vol. 125, No. 6, p 377-386, June, 1978. 8 fig, 4 tab, 19 ref, 14 equ.

Descriptors: Heavy metals, Humic acids, Electrodes, Pollutants, Copper, Cadmium, Lead.

A new technique based on the combined use of potentiometric titration and ion-selective electrodes was proposed for determining apparent stability constants (successive stability constants and overall stability constants) of divalent metal cation Cu(++), Pb(++), and Cd(++) complexes with humic acids. Fourteen humic acids from diverse sources, including humidified rice straw, were examined. The stability constants increased with an increase in pH, and the order of values obtained was Cu(++) > Pb(++) >>Cd(++). The overall logarithmic stability constants with the soil humic acid examined were 8.65 for Cu(++), 8.35 for Pb(++), and 6.25 for Cd(++) at pH 5.0. The overall stability constants of Cd(++) complexes ranged from 430,000 to 4.6 times 10 to the 7th power at pH 6.0. The overall stability constants increased with increasing humification in the higher humification range, and the values correspond to the contents of very weakly acidic functional groups. The binding mechanisms of the metal cation complexes with humic acids seemed to accompany the coordinate bonds of undissociated very weakly acidic functional groups, in addition to the ionic bonds through COOH and/or OH groups.

78:02K-003
FACTORS AFFECTING GYPSUM AND CATION EXCHANGE CAPACITY DETERMINATIONS IN GYPSIFEROUS SOILS,
Sayegh, A.H., Khan, N.A., Khan, P., and Ryan, J.
American University of Beirut, Lebanon, Department of Soils and Irrigation.
Soil Science, Vol. 125, No. 5, p 294-300, May, 1978. 4 fig, 15 ref.

Descriptors: Cation exchange, Gypsum, Calcium, Magnesium, Sodium compounds, Ammonium compounds, Soil profiles, Particle size.

Profiles of gypsiferous soils from the Euphrates basin of Iraq and Syria were studied. Increasing fineness of grinding, from 10, 50, 100, and 170 to 270-mesh, increased the measured amounts of gypsum and soluble Ca + Mg. These variables also increased as the soil:water ratio increased i.e., 1:50, 1:100, and 1:500. Cation exchange capacity values at 10, 100, and 270-mesh sizes were determined by various procedures: 1N NaOAC/NH4OAC solutions prepared with distilled water and with 1:1 water-acetone mixture; pretreatments of the soil with 2N BaCl2·2H2O, saturated Na2C2O4, and saturated (COOH)2·2H2O by shaking for variable periods up to six days. After each pretreatment, CEC was determined by the conventional NaOAC/NH4OAC procedure. Highest values were obtained after pretreatment, the order being Na2C2O4, BaCl2·2H2O, and (COOH)2·2H2O. Values increased with time of shaking during pretreatment and with increasing fineness of particle size. Criteria are presented for determining gypsum and CEC in soils containing significant amounts of gypsum.

78:02K-004
FERTILIZATION DECISION MODEL-A SYNTHESIS OF SOIL AND PLANT PARAMETERS IN A COMPUTERIZED PROGRAM,
Kafkafi, U., Bar-Yosef, B., and Hadas, A.
Institute of Soils and Water, Bet Dagan, Israel, ARO-The Volcani Center.
Soil Science, Vol. 125, No. 4, p 261-268, April, 1978. 1 fig, 2 tab, 43 ref, 3 append.

Descriptors: Fertilization, Computer models, Plant growth, Nitrates, Nitrogen, Phosphates, Potassium, Ammonium compounds, Nutrient removal, Root development.

A fertilization decision model was suggested, based on soil and plant parameters. The optimum concentration range of nitrate nitrogen in the soil solution, during the uptake period of the growing plant, was suggested to be 50 to 250 ppm N-NO3 for all soils and plants. The optimum bicarbonate-soluble P was found to vary with plant and soil type, and was determined by response experiments. Percent recovery of added fertilizer by bicarbonate extraction was used to calculate the amount of fertilizer needed to raise the extraction value to the optimum level. Exchangeable potassium was considered to be the only source important during the growing season of an annual crop. The uptake rate of nutrients during the growing season, depth of root penetration, and sensitivity to ammonium were considered to be the main plant parameters. The model calculates, at preset time intervals, the balance between the quantity of nutrients in the root zone and uptake by plants. A decision to add fertilizer is made if a deviation from the optimum exceeds a predetermined value.

78:02K-005
SIMULATION OF NITROGEN PROCESSES IN SOILS FOR ESTIMATING FERTILIZER REQUIREMENTS,
Kruh, G., Hagin, J., and Sharon, S.
Technion-Israel Institute of Technology, Haifa, Israel, Faculty of Agricultural Engineering.
Soil Science, Vol. 125, No. 4, p 255-260, April, 1978. 3 fig, 2 tab, 19 ref.

Descriptors: Fertilization, Computer models, Simulation analysis, Cotton, Ammonium compounds, Nitrates, Soil moisture, Crop response, Timing.

In a field experiment on cotton, ammonium sulfate was applied to give 60, 120, and 180 kg N/ha, all in winter, early spring, and late spring applications. A check treatment was included. Soil samples to a depth of 120 cm were taken from time to time, and moisture and nitrate concentrations were measured. The early spring fertilization at the two lower levels of application produced higher yields than the two other application times, with a maximum at the 120-kg N/ha level. The highest level of application induced a yield depression. The early spring application produced a nitrate distribution in the soil profile with a peak in the 20-40 cm depth. The yield results were partially explained by the nitrate distribution in the soil profile during the early growth period. A computer program simulated well, within experimental errors, the nitrate distribution in the soil profile. It was concluded that such a program could improve considerably nitrogen fertilizer requirements and timing predictions.

78:02K-006
HULA VALLEY PEAT: REVIEW OF CHEMICAL AND GEOCHEMICAL ASPECTS,
Brenner, S., Ikan, R., Agron., N.A., and Nissenbaum, A.
Hebrew University of Jerusalem, Israel, Department of Organic Chemistry.
Soil Science, Vol. 125, No. 4, p 226-232, April, 1978. 3 fig, 2 tab, 32 ref.

Descriptors: Peat, Chemical properties, Pleistocene epoch, Inorganic compounds, Organic matter, Stable isotopes, Elements (chemical), Geochemistry.

In the Hula Valley, Israel, four layers of peat of Middle Pleistocene to Holocene age, interbedded with limnic clays and marls, are found above 300-m depth. The main detrital minerals are kaolinite, montmorillonite, and illite. Average elemental values of organic and inorganic matters (on dry basis) present in each horizon and average calorific values of each horizon are reported. Organic constituents of the upper layer have been identified. A detailed quantitative investigation of the distribution with depth in the top peat layer of the humic, fulvic, and hymatomelanic acids, as well as of the beta-humus and humin, showed humin to be the dominant fraction of the organic matter. Analysis of the peat organic fractions for carbon and hydrogen stable isotopes shows that with depth the difference in delta C13 between the humic and fulvic acids disappears and the delta C13 stabilized at around-18 parts per thousand. The isotope data indicate the dynamic nature of the fulvic acid in the peat. The delta D values were around-60 parts per thousand, but the data are too meager for any firm conclusion.

78:02K-007
THE NATURE OF BASALT WEATHERING IN ISRAEL,
Singer, A.
The Hebrew University of Jerusalem, Israel, Department of Soil and Water Science.
Soil Science, Vol. 125, No. 4, p 217-225, April, 1978. 5 fig, 17 ref.

Descriptors: Weathering, Soil formation, Basalts, Aeolian soils, Saprolites, Clay minerals, Quartz.

Three major weathering forms of upper Cenozoic basalts are recognized: a weathering crust, several millimeters thick, at the interface with the massive basalt; a weathering zone, several centimeters thick, associated with vesicular basalt; and thoroughly altered basalt saprolite, mostly obtained under prolonged water-saturated conditions. The clay fractions in the weathering crust and zone consist of smectite and kaolinite with halloysite, while, in the saprolite, smectite is the only clay mineral formed. SiO_2/Al_2O_3 ratios change from 6-7 in the rock to 2-3 in the crust clay, and this decrease represents maximum desilication obtained under eastern Mediterranean conditions. With soil development, a resilication of soil clays relative to crust clay may take place in the deeper stable profiles. Soil development also involves aeolian accumulation of quartz in the coarser size fractions, and Fe and K enrichment in the clay fraction. Grumusols (Vertisols) represent the mature, stable end products of basalt weathering on uneroded surfaces in the semi-arid and subhumid parts of the eastern Mediterranean. In the more humid parts, Red and Brown Mediterranean soils (Xeralfs) become dominant.

78:02K-008
APPLICATION OF THE ELECTRICAL DOUBLE LAYER THEORY TO PREDICT ION ADSORPTION IN MIXED IONIC SYSTEMS,
Ravina, I., and Gur, Y.
Technion-Israel Institute of Technology, Haifa, Israel, Faculty of Agricultural Engineering.
Soil Science, Vol. 125, No. 4, p 204-209, April, 1978. 3 fig, 3 tab, 16 ref, 16 equ.

Descriptors: Cation adsorption, Alkali metals, Ions, Hydration, Soil chemistry.

A Poisson-Boltzmann equation including hydration forces and the dielectric saturation effects for describing the electric double layer was presented and compared with the Gouy-Chapman theory. Ionic concentrations in the double layer were calculated by the revised equation showing the specific adsorption of the various alkali metal cations.

78:02K-009
RESIDUAL FORMS OF FERTILIZER NITROGEN IN FIELD SOILS,
Smith, S.J., Chichester, F.W., and Kissel, D.E.
U.S. Agricultural Water Quality Management Laboratory, Durant, Oklahoma.
Soil Science, Vol. 125, No. 3, p 165-169, March, 1978. 1 fig, 2 tab, 17 ref.

Descriptors: Fertilizers, Nitrogen, Chemical analysis, Nitrates, Chemical reactions, Aerobic conditions, Soil chemistry.

Residual fertilizer N was characterized in Houston Black clay and Keene silt loam surface soils from recent field microplot-N balance studies involving liberal (328-560 kg N/ha) 15N-labeled rates. Results indicate residual N is readily distributed in all the organic and inorganic soil N forms, even after the first cropping season. An equivalent distribution of the residual N with the indigenous soil N, however, had not occurred after three years. During this period the residual N was more than twice as susceptible to mineralization as the soil N. Most of the residual N was incorporated in amino acid N-forms.

78:02K-010
MECHANISM OF ZINC ADSORPTION BY IRON AND ALUMINUM OXIDES,
Kalbasi, M., Racz, G.J., and Loewen-Rudgers, L.A.
University of Manitoba, Winnipeg, Manitoba, Canada, Department of Soil Science.
Soil Science, Vol. 125, No. 3, p 146-150, March, 1978. 1 fig, 1 tab, 13 ref.

Descriptors: Adsorption, Zinc, Iron oxides, Aluminum, Ion exchange, Aqueous solutions, Soil chemistry, Hydrogen ion concentration, Chlorides.

Adsorption of Zn from aqueous solutions of ZnCl2 by hydrated Al203 and Fe203 was highly pH-dependent and increased markedly with increasing pH. Fe203 had a higher Zn adsorption capacity, at equivalent pH values, than Al203. Experimental observations suggested that surface aqus (-OH2) and hydrono (-OH) groups were involved in Zn adsorption. In addition, experimental observations lead to the postulation that two types of adsorption, specific and nonspecific, depending upon reversibility (exchangeability with Ba(2+)), occurred. Specific and nonspecific adsorptions of Zn(2+) were accounted for 60 to 90% and 40 to 10% of the total Zn adsorption respectively. For specific adsorption, an olation bridge structure between Zn(2+) and two surface -OH2 groups was postulated; and for nonspecific adsorption, a single-bond structure in which ZnCl(+) replaced one H(+)from surface -OH2 groups was postulated. The ratio of specific to nonspecific adsorption increased with increasing pH. It was concluded that specific adsorption of Zn by Al203 and Fe203 may be at least partially responsible for the frequency reported fixation and unavailability of added Zn to soils.

78:02K-011
CHEMICAL CHARACTERIZATION OF LOCAL AND STRATOSPHERIC PLUTONIUM IN OHIO SOILS,
Muller, R.N.
Argonne National Laboratory, Argonne, Illinois, Radiological and Environmental Research Division.
Soil Science, Vol. 125, No. 3, p 131-136, March, 1978. 1 fig, 5 tab, 21 ref, 1 append.

Descriptors: Isotope studies, Chemical analysis, Ecosystems, Industrial wastes, Soil contamination, Ohio.

The chemical nature of plutonium derived from stratospheric fallout and industrial sources was studied in three agricultural soils. The majority of the soil plutonium was associated with a reductant-soluble, hydrous oxide phase that, under most conditions of terrestrial ecosystems, remains essentially immobile. The proportion of plutonium associated with organic matter (0.1N NaOH-extractable) varied among soils, and increased with decreasing particle size in the same soil. In a soil containing 238Pu from a local fabrication facility and 239,240Pu from stratospheric fallout, isotopic ratios between the NaOH-extractable and residual phases were essentially constant, indicating that, in these soils, plutonium from both sources behaves similarly. The distribution of soil plutonium with particle size appears to be most directly related to the mass of the soil particle.

78:02K-012

EFFECTS OF TEMPERATURE AND TIME ON HYDROXY ALUMINUM PHOSPHATE-MONTMORILLONITE COMPLEX,

Webber, M.D.
Soil Research Institute, Agriculture Canada, Ottawa, Ontario K1A 0C6.
Soil Science, Vol. 125, No. 2, p 107-114, February, 1978. 3 fig, 3 tab, 16 ref.

Descriptors: Montmorillonite, Aluminum, Phosphates, Clay minerals, Temperature, Time, Solubility, Suspension, Aerobic conditions, Acidic soils.

Hydroxy aluminum phosphate-montmorillonite complex persisted for 320 days in aqueous aerobic suspensions that exhibited a pH range of 2.5 to 3 and were maintained at 10, 25, and 35C. There were small changes in its chemical and x-ray diffraction properties with time, and these occurred more quickly as the temperature was raised. It persisted for 100 to 200 days at 50C, but then variscite formed and interlayer material disappeared from the clay. Solubility calculations indicated that preparations containing the complex were undersaturated with respect to gibbsite and supersaturated with gibbsite, but saturated with variscite. Seeding the preparations with variscite and aging at 25C did not cause variscite to form. It is postulated that amorphous hydroxy aluminum phosphate, which is an important soil-fertilizer reaction product and a good source of phosphorus for plants on neutral soil, is likely to persist indefinitely in temperate acid soils.

78:02K-013

REACTION PRODUCTS AND SOLUBILITY OF APPLIED ZINC COMPOUNDS IN SOME MANITOBA SOILS,

Kalbasi, M., Racz, G.J., and Lewen-Rudgers, L.A.
University of Manitoba, Winnipeg, Manitoba, Canada, Department of Soil Science.
Soil Science, Vol. 125, No. 1, p 55-64, January, 1978. 4 fig, 6 tab, 26 ref.

Descriptors: Zinc, Solubility, Sulfates, Sulfides, Ammonium compounds, Fertilizers, X-ray diffraction, Calcareous soils, Soil chemistry.

ZnSO4, ZnEDTA, ZnS, and ZnSO4 plus NH4H2PO4 were banded in soils, and the solid-phase zinc compounds were identified using x-ray diffraction analysis. Solubility of zinc in soil adjacent to the fertilizer band was determined by measuring the zinc concentration in soil-water extracts. The reaction product in a noncalcareous soil (pH 8.2) treated with ZnSO4, was Zn(OH)2, which was metastable and persisted for only a few weeks. ZnSO4 was usually precipitated as ZnCO3 and Zn5(CO3)2(OH)6 in the calcareous soils. No crystalline reaction products were detected in soils treated with ZnEDTA. Zn5(CO3)2(OH)6 and Ca[Zn(OH)3]2·2H2O were found in a calcareous soil treated with ZnS and incubated for 32 weeks. Zn3(PO4)2·4H2O and NH4ZnPO4 were identified in soils treated with ZnSO4 plus NH4H2PO4. Concentrations of zinc in water extracts of soils treated with zinc increased in order: ZnS, ZnSO4, ZnEDTA. Zinc concentration in water extracts of soils treated with ZnSO4 or ZnEDTA decreased with time of incubation, whereas it increased in soils treated with ZnS. Addition of phosphate to ZnSO4 decreased zinc concentrations in soil-water extracts, as compared to soils treated only with ZnSO4.

78:02K-014

TRANSFORMATIONS OF ORGANIC PHOSPHORUS SUBSTRATES IN SOILS AS EVALUATED BY NaHCO3 EXTRACTION,

Bowman, R.A., and Cole, C.V.
United States Department of Agriculture, Agricultural Research Service, Fort Collins, Colorado.
Soil Science, Vol. 125, No. 1, p 49-54, January, 1978. 1 fig, 4 tab, 20 ref.

Descriptors: Chemical analysis, Organic compounds, Inorganic compounds, Phosphorus, Phosphorus compounds, Soil chemistry, Incubation.

The sodium-bicarbonate method of Olsen et al. was primarily designed to extract inorganic P (PI) and to correlate this P-pool with plant response. This procedure was used to follow the transformations of organic P (PO) substrates in soil. Various commercial PO substrates were added to a sandy loam soil, and were extracted immediately and after one to eighteen days of incubation at field capacity. Glycerophosphate and all 3' nucleotide components of RNA were completely mineralized and accounted for in the NaHCO3 solution after three days. While RNA degraded in eighteen days, sodium inositol hexaphosphate (Na-phytate) was relatively unaffected during this time and unrecoverable in the NaHCO3 solution upon immediate extraction. Thus, the labile compounds, like RNA, its four 3' nucleotides, and glycerophosphates were recoverable in the 0·5M NaHCO3-extracting solution (pH 8.5) of Olsen et al., while the Na-phytate, a relatively resistant compound, was not. Native Po was only slightly affected. However, a relatively constant amount of native Po was extracted, irrespective of extraction periods lasting 0.5 to 6 h.

78:02K-015
THE BEHAVIOR OF SULFATE ON SALT INPUT IN PODZOLIC BROWN EARTH,
Khanna, P.K., and Beese, F.
Georg-August University, Buesgenweg 2, Goettingen, West Germany, Institute of Soil Science and Forest Nutrition.
Soil Science, Vol. 125, No. 1, p 16-22, January, 1978. 4 fig, 3 tab, 17 ref.

Descriptors: Sulfates, Salts, Adsorption, Chemical precipitation, Podzols, Effluents, Leachate, Sorption, Inorganic compounds.

The behavior of sulfate concentration in the leachate of an acid podzolic brown earth was studied, when a slug of neutral salt (KCl + KNO3) passed through the upper sulfate-enriched layers of the soil. The effluent of five undisturbed soil columns was collected daily, and H(+), Cl(-), and SO4(--) concentrations were measured. A constant flux of water, either 1.0 cm/day or 0.3 cm/day, was maintained. Sulfate concentration in the leachate showed a decrease when the salt passed the columns. The decrease corresponded with an increase of H(+) and Cl(-) concentrations. The behavior of sulfate was almost the same irrespective of the flow rates. At the lower rate, sulfate retention was about twice that at the higher rate. Though precipitation of basic aluminum sulfates cannot be excluded, the behavior of sulfate must be interpreted in terms of specific adsorption.

78:02K-016
FIELD PERSISTENCE AND MOVEMENT OF TRIFLURALIN IN TWO SOIL TYPES,
Duseja, D.R., and Holmes, E.E.
Tennessee State University, Nashville.
Soil Science, Vol. 125, No. 1, p 41-48, January, 1978. 1 fig, 8 tab, 27 ref.

Descriptors: Herbicides, Weed control, Weeds, Johnson grass, Oats, Movement, Persistence.

Trifluralin (alpha, alpha, alpha-trifluoro-2, 4, dinitro-N, N-dipropyl-p-toluidine) was applied in 1973 to Egam load and Beason clay field plots. Trifluralin persistence and movement in both soils was essentially the same, even though higher herbicide rates were applied to Beason clay, according to manufacturer's recommendations. There was an increasing trend of herbicide residues with excessive rates of trifluralin application. The herbicide essentially dissipated from soils in five months, with only 2.1 percent and 0.4 percent of the initially applied amounts remaining in the soil profile, in the Egam and Beason soils, respectively, at the highest (two times) rate of herbicide application. No herbicide was detected in the soil the following spring (eleven months after application). Herbicide persistence could be described by a first-order kinetics. Downward movement of trifluralin under the conditions of this experiment did occur to the eight in depth; further penetration of herbicide was essentially nil. Apparently, upward movement of trifluralin also occurred under these conditions. The control of Johnson grass and two broadleaf weed species present in the soil lasted from four to five weeks only.

78:02K-017
NITRAPYRIN DEGRADATION AND MOVEMENT IN SOIL,
Touchton, J.T., Hoeft, R.G., and Welch, L.F.
Georgia University, Georgia Station, Experiment, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 5, p 811-816, September-October, 1978. 5 fig, 5 tab, 13 ref.

Descriptors: Nitrification, Inhibitors, Degradation (decomposition), Movement, Ammonium compounds, Ammonia, Fertilizers, Soil chemical properties, Soil physical properties.

Nitrapyrin [2-chloro-6-(trichloromethyl)pyridine] is applied with ammonium-N fertilizers to control nitrification in soil. However, little information is available on the persistence or loss of field-applied nitrapyrin. The objective of this study was to monitor movement and degradation of nitrapyrin in soil. Nitrapyrin was applied with anhydrous ammonia in the fall of 1975 and spring of 1975 and 1976. Measurable quantities of nitrapyrin were not found beyond 7.5 cm from the point of release in the soil. The distance that nitrapyrin moved from the point of release in the soil was not affected by nitrapyrin rates. Greater nitrapyrin movement was not detected in one direction from the point of release in the soil than in another direction. Increasing rates of anhydrous ammonia had no effect on nitrapyrin movement of degradation. The most rapid rate of degradation occurred soon after application and decreased with time. The data suggest that nitrapyrin degradation and movement will depend on the physical and chemical characteristics of the soil. Even though degradation rates decreased with time, no indication was found to prove that soil accumulations of nitrapyrin will result from once-a-year applications.

78:02K-018
EFFECT OF NITRAPYRIN ON NITRIFICATION OF FALL AND SPRING-APPLIED ANHYDROUS AMMONIA,
Touchton, J.T., Hoeft, R.G., and Welch, L.F.
Illinois University, Urbana, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 5, p 805-810, September-October, 1978. 5 fig, 5 tab, 15 ref.

Descriptors: Nitrification, Inhibitors, Denitrification, Nitrates, Fertilizers, Ammonia, Leaching, Timing, Rates of application, Soil types.

Nitrification of ammonium fertilizers in late fall and early spring and subsequent nitrate losses through leaching and denitrification are a continuing economical and environmental concern. To evaluate the effects of nitrapyrin on nitrification, anhydrous ammonia with and without nitrapyrin was applied in the fall and spring to poorly drained soils. Nitrogen and nitrapyrin rates ranged from 0 to 268 and 0 to 1.12 kg/ha, respectively. Detailed sampling from ammonia retention zones was conducted throughout the fall, spring, and summer. Effects of nitrapyrin on nitrification varied with time of application, nitrapyrin rate, and soil type.

78:02K-019
NITROGEN RELEASE CHARACTERISTICS OF ISOBUTYLIDENE DIUREA AND ITS EFFECTIVENESS AS A SOURCE OF N FOR FLUE-CURED TOBACCO,
Miner, G.S., Lilly, J.P., and Terry, D.L.
North Carolina State University, Raleigh, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 3, p 434-438, May-June, 1978. 3 fig, 3 tab, 12 ref.

Descriptors: Nitrogen, Leaching, Tobacco, Nutrient removal, Fertilizers, Particle size.

The objectives of this study were to investigate the release characteristics of isobutylidene diurea (IBDU), with N-release characteristics dependent primarily upon the effects of particle size on chemical dissolution rather than the effects of environmental variation on biological activity, in laboratory and greenhouse studies and to evaluate it as a source of N for flue-cured tobacco in the field. Urea, NaNO3, and four particle sizes of IBDU (1.05, 0.75, 0.55, and 0.40 mm) were applied at rates of 200 and 400 mg N per kg of soil to a Norfolk sandy loam (Typic paleudult) in lysimeters and subjected to leaching at ten intervals over a 109-day period. Percentage removal of N from these sources were observed at a different leaching time. The effects of particle size of IBDU on dry matter and N uptake were studied to determine their N release characteristics. IBDU particle sizes of 1.05 and 0.40 mm were compared with NaNO3 and Urea as N sources for flue-cured tobacco.

78:02K-020
FATE OF FERTILIZER NITRATE APPLIED TO COASTAL BERMUDAGRASS ON A SWELLING CLAY SOIL,
Kissel, D.E., and Smith, S.J.
Texas Agricultural Experiment Station, Temple, Blackland Research Center.
Soil Science Society of America Journal, Vol. 42, No. 1, p 77-80, January-February, 1978. 3 tab, 16 ref.

Descriptors: Nitrates, Denitrification, Fertilizers, Bermudagrass, Soil physical properties.

The disposition of N fertilizer applied to Coastal bermudagrass in the field over two growing seasons was determined by applying 560 kg N/ha as $Ca(NO_3)_2$ tagged with 7.599 atom % ^{15}N to a field microplot during 1974 and measuring various components of the N balance. Plant uptake of residual N was measured during 1975. Forty-nine percent of the applied N was recovered in harvested forage in 1974. About 40% of the applied N remained in the soil as residual N at the end of 1974. About 10% of N was unaccounted for, indicating that denitrification losses were no more than 10% of the applied N. Most of the residual N at the end of the first growing season was immobilized N or was present in the root system of the grass. Immobilization is, therefore, a major factor causing low recovery of applied N by Coastal bermudagrass on swelling clay soils. Moreover, since only 17% of the residual N was recovered in forage during 1975 (7% of the N applied in 1974), most of the immobilized N was not available the following year.

78:02K-021
IMPORTANCE OF THE ORGANIC PHOSPHORUS FRACTION IN EXTRACTS OF CALCAREOUS SOIL,
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Cotton Research Center, 4201 E. Broadway, Phoenix, Arizona 85040.
Soil Science Society of America Journal, Vol. 42, No. 1, p 81-85, January-February, 1978. 2 fig, 8 tab, 10 ref.

Descriptors: Soil analysis, Calcareous soils, Phosphorus, Forage sorghum, Fertilizers, Organic compounds, Soil chemistry.

Laveen clay loam soil samples were collected immediately following the harvest of forage sorghum (Sorghum bicolor (L.) Moench). Two sets were prepared before growing turnips (Brassico rapa L.) as the test crop in the greenhouse. One set was without treatment and the other, to simulate winter and spring conditions, was incubated for twenty days after addition of N and dextrose. Phosphorus uptake by turnips and changes in soil P forms were positively correlated with corresponding measurements taken during the growth of the sorghum crop. Correlations among P uptake by forage sorghum, turnips, and soil P measurements indicated their value in predicting available P. Prediction values for two of the procedures were improved by including the extractable organic P with the inorganic P for the incubated soil. Results showed that (1) time of sampling, (2) the crop to be grown, (3) the method of extraction, and (4) the means of converting organic P to a measurable inorganic form in the extract are of prime concern in deciding when to include extractable organic P in the P evaluation of a given soil.

78:02K-022
MINERALIZATION, IMMOBILIZATION AND NITRIFICATION,
Broadbent, F.E.
California University, Davis, Department of Land, Air and Water Resources.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 109-134, May 15-18, 1978. 5 fig, 3 equ, 33 ref.

Descriptors: Nitrogen, Nitrification, Ammonia, Decomposing organic matter, Soil microorganism, Inorganic compounds, Pollutants, Inhibitors.

The decomposition of organic substances containing nitrogen through the activities of soil microorganisms and resulting in the release of some of the nitrogen as ammonia is called nitrogen mineralization. Net mineralization occurs when the quantity of nitrogen in the material undergoing decomposition exceeds the needs of the microbial population for nitrogen to produce new cells. If the decomposing substances do not contain enough nitrogen to meet the needs of the microbial population, any inorganic nitrogen present in the soil will be utilized by the microbes and converted to cell protein and other nitrogenous compounds. This process is called immobilization. In a sense the assimilation of inorganic nitrogen by growing plants is also immobilization, but this discussion considers only the microbiological process. The nitrogen supplying capacity of soils depends to a large extent on rates of mineralization and immobilization. Various procedures have been utilized to obtain estimates of nitrogen mineralization over a growing season, the most successful of which have been based on incubation of soil samples under controlled conditions for a few weeks. Desirable management practices should favor not only efficient utilization of fertilizer nitrogen, but also maximum crop uptake of mineralized nitrogen. Experiments with isotopically labeled fertilizers indicate that these two objectives are compatible with each other and also with the need to minimize leachable nitrate.

78:02K-023
SIMULATION OF NUTRIENT LOSS FROM SOILS DUE TO RAINFALL ACIDITY,
Reuss, J.O.
Environmental Research Laboratory-Corvallis, Corvallis, Oregon, Office of Research and Development, United States Environmental Protection Agency.
Publication No. EPA-600/3-78-053, May, 1978. 45 p, 12 fig, 4 tab, 18 ref.

Descriptors: Rainfall, Water analysis, Water chemistry, Soil science, Soil chemistry, Plant nutrition, Ecology.

This paper describes a simulation model that provides a quantitative system utilizing established relationships from soil chemistry to predict the most likely effect of rainfall acidity on the leaching of cations from noncalcareous soils. The model utilizes the relationships between lime potential (pH - 1/2pCa) and base saturation described by Clark and Hill (Soil Sci. Soc. Amer. Proc. 28:490-492, 1962) and Turner and Clark (Soil Sci. 99:194-199, 1964), the equilibrium between CO2 partial pressure and H+ and HCO3- in solution, the apparent solubility product of AL(OH)3, the equilibrium of cations and anions in solution, the Freundlich isotherm description of ions between the solution and sorbed or exchangeable phases. Ionic composition of leachates in response to rainfall composition can thus be computed. Ions considered in the present version are H+, Ca2+, Al3+, SO42-, CL-, and HCO3-. The model predicts almost exact chemical equivalence between basic cation removed in the leachate and strong acid anions entering the system in the rainfall of pH - 1/2pCa is above 3.0, at which point the base saturation will generally not exceed 20%. At lower pH - 1/2pCa values leaching of anions in association with H+ and Al3+ becomes significant and these cations predominate when pH - 1/2pCa falls below 2.0.

78:02K-024
MULTICOMPONENT CATION ADSORPTION DURING CONVECTIVE-DISPERSIVE FLOW THROUGH SOILS: EXPERIMENTAL STUDY,
Lai, S-H., Jurinak, J.J., and Wagenet, R.J.
Utah State University, Logan, Department of Soils and Biometeorology.
Soil Science Society of America Journal, Vol. 42, No. 2, p 240-243, March-April, 1978. 5 fig, 14 ref, 2 equ.

Descriptors: Cation adsorption, Cation exchange, Soil water movement, Solutes, Sodium, Magnesium, Calcium, Isotherms.

The adsorption of H(+), Mg(2+), and Ca(2+) from aqueous solutions flowing through soil was examined under different total cation concentrations and input pulse volumes. The pulses of H(+) and Mg(2+), which were introduced into a Ca(2+)-saturated Yolo loam soil column, appeared separately in the effluent. The degree of separation decreased with total concentration, but was not affected significantly by the pulse volume. At constant total concentration, the initial appearance of the Mg(2+) pulse was delayed with increasing pulse volume. The experimental results were compared to theoretical calculations based on a single component linear equilibrium model. At a low loading (a small amount of adsorbate with respect to a large amount of adsorbent), the agreement of the theoretical model and the experimental results was satisfactory. However, when the loading was increased, the discrepancy between the calculated values and the experimental results increased.

78:02K-025
ADSORPTION OF ALDICARB BY CLAYS AND SOIL ORGANO-CLAY COMPLEXES,
Supak, J.R., Swoboda, A.R., and Dixon, J.B.
Texas A & M University, College Station, Department of Soil and Crop Science.
Soil Science Society of America Journal, Vol. 42, No. 2, p 244-248, March-April, 1978. 3 fig, 3 tab, 22 ref.

Descriptors: Carbamate pesticides, Systemics, Insecticides, Adsorption, Illite, Montmorillonite, Kaolinite, Clay minerals.

Adsorption experiments conducted with S-methyl-14C-aldicarb resulted in what appeared to be negative adsorption (exclusion) of the toxicant on Ca- and Al-saturated montmorillonite clays. Calculated exclusion volumes indicated that aldicarb did not penetrate the interlamellar region. Aldicarb was excluded from at least the first 16 layers of water on external surfaces of montmorillonite. Positive adsorption occurred with Ca- and Al- saturated illite and kaolinite clays. Equilibration of aldicarb solutions with one acid and two calcareous Vertisols, and with the organo-clay complexes isolated from these Vertisols, produced negative adsorption isotherms for the acid and positive adsorption isotherm for calcareous adsorbents.

78:02K-026

POTASSIUM AND RUBIDIUM ADSORPTION AND DIFFUSION IN SOIL,

Baligar, V.C., and Barber, S.A.
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Soil Science Society of America Journal, Vol. 42, No. 2, p 251-254, March-April, 1978. 2 fig, 4 tab, 10 ref, 6 equ.

Descriptors: Cation adsorption, Cation exchange, Potassium, Cations, Diffusion, Correlation analysis, Organic matter.

The adsorption of K and Rb by four soils was investigated to determine the differences in adsorption of K and Rb which may occur and how they are affected by soil properties with the view of using this information to evaluate the intake mechanisms for K and Rb by plant roots growing in soil. Rubidium was adsorbed preferentially to K by all four soils. Selectivity coefficient k sub Rb/K, indicating the size of the effect ranged from 1.9 to 4.4. Adding K decreased k sub Rb/K, increased the amount of nonexchangeable Rb and decreased exchangeable Rb. There was a negative correlation (coefficient of determination = 0.78) between exchangeable K in the soil and k sub Rb/K. The level of K in the soil had a greater effect on k sub Rb/K than varying types of exchange sites present due to differences in clay and amounts of organic matter in the four soils investigated. The size of the selectivity coefficient indicated that the difference between K/Rb ratios in the solution and exchange phases of these soils used and differences between soils made them suitable for use in plant uptake studies of the mechanisms of K and Rb uptake.

78:02K-027

THE DISTRIBUTION OF MICRONUTRIENT CATIONS IN SOIL UNDER CONDITIONS OF VARYING REDOX POTENTIAL AND pH,

Sims, J.L., and Patrick, W.H., Jr.
Kentucky University, Lexington, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 2, p 258-262, March-April, 1978. 5 tab, 19 ref.

Descriptors: Iron, Manganese, Zinc, Copper, Organic matter, Nutrient removal, Flooding, Toxicity.

A laboratory study was conducted to determine the influence of redox potential and soil pH on the distribution of Fe, Mn, Zn, and Cu in Mhoon silty clay loam soil (Typic Fluvaquents) and to provide insight into factors affecting micronutrient dissolution and mobility in soil. Generally, greater amounts of Fe, Mn, Zn, and Cu were found in the Na acetate (exchangeable) and pyrophosphate (organic) extractions at low pH and Eh than at high pH or Eh. In contrast, the amounts (except Mn) in the water-soluble, NH2OH·HCl, and oxalate fractions were greater at high pH or Eh. Although the micronutrients were brought into solution at low pH and Eh, much of the soluble cations soon associated with the exchangeable and organic fractions. After reduction, mobilized Fe associated about equally with the exchangeable, organic, and NH2OH·HCl fractions; immobilized Mn with the exchangeable and water-soluble fractions; mobilized Zn with the organic fraction; and the mobilized Cu with the organic and water-soluble fractions. Separation of the water-soluble fraction into free ions and those complexed by soluble organic matter indicated that micronutrient cations were complexed by organic matter to a greater extent in reduced soil.

78:02K-028

DETERMINING SOIL GYPSUM CONTENT AND EXPRESSING PROPERTIES OF GYPSIFEROUS SOILS,

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National Soil Survey Laboratory, Lincoln, Nebraska, Soil Conservation Service.
Soil Science Society of America Journal, Vol. 42, No. 4, p 659-661, July-August, 1978. 1 fig, 2 ref, 18 equ.

Descriptors: Gypsum, Sulfates, Soil water, Soil chemical properties, Soil tests, Soil chemistry.

The standard method for measuring the gypsum content of soils is a lengthy one, partly because of the presence of Na and Mg sulfates in most gypsic horizons, and partly because of the difficulty in dissolving all the gypsum in the sample. A more rapid method, sufficiently accurate for taxonomic uses, has been developed and is based on loss of crystal water of gypsum upon heating to 105 C. Percent gypsum, calculated on an oven-dry weight basis from loss of crystal water, equals 1.038 x percent gypsum by the standard chemical method + 0.17. The standard error of estimate for the new methods is ± 1.8% gypsum. Equations are given for expressing properties of gypsiferous soils on an oven-dry + crystal water of gypsum weight basis.

78:02K-029

THE ACETYLENE INHIBITION METHOD FOR SHORT-TERM MEASUREMENT OF SOIL DENITRIFICATION AND ITS EVALUATION USING NITROGEN-13,

Smith, M.S., Firestone, M.K., and Tiedje, J.M.
Michigan State University, East Lansing, Department of Crop and Soil Sciences.
Soil Science Society of America Journal, Vol. 42, No. 4, p 611-615, July-August, 1978. 1 fig, 6 tab, 11 ref.

Descriptors: Denitrification, Inhibitors, Nitrogen, Reduction (chemical), Anaerobic conditions, Aerobic treatment.

Acetylene was found to effectively inhibit the reduction of N20 by anaerobic soils. With concentrations of C2H2 above 0.1 atm, added NO3(-) was quantitatively converted to N2O and added N2O was reduced at an insignificant rate. Experiments with 13N demonstrated that at low soil nitrate concentrations at least 0.1 atm C2H2 was required for effective inhibition. Denitrification rates determined by 13N and by C2H2 inhibition methods correlated well, as did determination of N2O/(N2 + N2O). The methods also revealed that an acceleration in denitrification rate occurred within a few hours after soil was exposed to anaerobic conditions. The acetylene method was generally used to measure denitrification rates in soils incubated as anaerobic slurries, but was also used to determine rates for field moist aggregrates incubated anaerobically and aerobically. When assayed as anaerobic slurries, initial denitrification rates ranged from 0.1 to 0.7 mmoles N gas/soil/min for the mineral soils examined. The denitrification rate in aerobic aggregrates was approximately 1,000 times less, showing the strong inhibitory effect of O2 on the indigenous denitrifying enzymes.

78:02K-030

THE MECHANISM OF SULFATE ADSORPTION ON IRON OXIDES,

Parfitt, R.L., and Smart, R. St. C.
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Soil Science Society of America Journal, Vol. 42, No. 1, p 48-50, January-February, 1978. 5 fig, 2 tab, 17 ref.

Descriptors: Sulfates, Adsorption, Iron oxides, Isotherms, Spectroscopy, Structural models, Soil chemistry.

Adsorption isotherms were determined for sulfate adsorption on iron oxides under acid conditions. The product of the surface reaction between the iron oxides and sulfate ions was examined by infrared spectroscopy which showed four bands in the upsilon S-O stretching region. Thus a structural model could be obtained for the reaction. Two surface hydroxyl groups (or OH2(+) ions) are replaced by one sulfate ion, and two oxygen atoms of the sulfate ion are coordinated each to a different Fe(3+) ion, resulting in the binuclear bridging surface complex Fe-O-S(O2)-O-Fe. The complex is formed on the surfaces of goethite (alpha-FeOOH), akaganeite (beta-FeOOH), lepidocrocite (gamma-FeOOH), hematite (alpha-Fe2O3) and amorphous ferric hydroxide.

78:02K-031

POTENTIAL USE OF FINELY DISINTEGRATED IRON PYRITE IN SODIC AND IRON-DEFICIENT SOILS,

Vlek, P.L.G., and Lindsay, W.L.
Colorado State University, Fort Collins, Department of Agronomy.
Journal of Environmental Quality, Vol. 7, No. 1, p 111-114, January-March, 1978.
3 fig, 3 tab, 15 ref.

Descriptors: Pyrite, Oxidation, Sulfur, Fertilizers, Mine wastes, Soil amendments, Colorado.

The rate of chemical oxidation of iron pyrite in water was measured as a function of particle size. Reducing the particle size greatly increased the rate of oxidation. For pyrite > 250 microns, the pH of the solution leveled off at 5 after six hours while the clay size pyrite dropped to pH4 within twenty-four hours. In these studies, pyrite was applied at 1% initially with an additional 1% after one month to a slightly sodic, iron-deficient, loamy sand soil from Colorado. The soil/water ratio was 1:2. When clay size pyrite was used, the pH of the soil decreased from 8.3 to 7.8 after 1 mo and to 5.7 after 2 mo. The coarser pyrite decreased the pH only slightly. No significant change in the composition of exchangeable ions occurred during the first month, but the composition had changed sufficiently after 2 mo to flocculate the clay. The DTPA-extractable iron increased from 1.5 to 64 ppm for the finest pyrite treatment during 1 mo, copper double, and manganese quadrupled during this period. Finely disintegrated pyrite may be useful for reclaiming slightly sodium-affected soils or for providing slow release available iron.

78:02K-032

PHOSPHATE ADSORPTION-DESORPTION CHARACTERISTICS OF SOILS AND BOTTOM SEDIMENT IN THE MAUMEE RIVER BASIN OF OHIO,

McCallister, D.L., and Logan, T.J.
Texas A & M University, College Station, Department of Agronomy.
Journal of Environmental Quality, Vol. 7, No. 1, p 87-92, January-March, 1978.
2 fig, 6 tab, 27 ref.

Descriptors: Adsorption, Eutrophication, Pollutants, Phosphates, Runoff, Isotherms.

Langmuir adsorption isotherms showed that Maumee River Basin sediments had adsorption capacities 10 to 20 times greater than Basin soils. Although the soil clay fractions had adsorption capacities higher than the whole soil, they were considerably less than those of the sediments and the difference is attributed to the higher content of amorphous or low-range order iron and aluminum components in the bottom sediments. Equilibrium phosphorus concentration (EPC) and phosphorus desorbed was similar for soil and sediments as well as total P, indicating that although the bottom sediments have a high capacity to adsorb P, this capacity has not been realized. Correlations between adsorption-desorption parameters and soil/sediment properties are presented. Bray P1 "available" P was highly correlated with EPC and P desorbed in the soils but to a lesser extent in the bottom sediments. CDB and oxalate extractable-P was highly correlated with P adsorption capacity in the bottom sediments but not in the soils.

78:02K-033

MICROBIAL ASPECTS OF THE VOLATILE LOSS OF APPLIED MERCURY (II) FROM SOILS,

Landa, E.R.
Oregon State University, Corvallis, Department of Soil Science and Agricultural Chemistry.
Journal of Environmental Quality, Vol. 7, No.1, p 84-86, January-March, 1978.
1 fig, 1 tab, 21 ref.

Descriptors: Autoclaves, Mercury, Volatility, Microbial degradation, Soil amendments, Montana.

Five surface soils from southeastern Montana were studied to determine the effects of autoclaving and glucose additions on the volatile loss of applied divalent inorganic mercury. Soils were amended to 1 ppm Hg as 203 Hg - Hg (NO3)2, maintained at room temperature near the 1/3-bar moisture content, and Hg content monitored for seven weeks. Mercury losses from soils receiving neither autoclaving or glucose additions ranged from 5 to 30%. In general, autoclaving reduced the total quantity of Hg lost, while glucose additions increased the initial loss rate of applied Hg.

78:02K-034
COPPER AND CADMIUM ADSORPTION CHARACTERISTICS OF SELECTED ACID AND CALCAREOUS SOILS,
Cavallaro, N., and McBride, M.B.
Cornell University, Ithaca, New York, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 550-556, July-August, 1978. 9 fig, 2 tab, 27 ref.

Descriptors: Heavy metals, Copper, Cadmium, Adsorption, Ion exchange, Acidic soils, Calcareous soils, Soil chemistry, New York.

Samples of two New York soils, an acid and a neutral silt loam, were equilibrated with Cu(2+) and Cd(2+) solutions in concentrations ranging from 0.00001 to 0.0001M in distilled water and in 0.01M CaCl2. The extent of complexation and adsorption of the heavy metals was measured using specific ion electrodes and atomic absorption. The data were found to fit the Langmuir adsorption model, and the Cu(2+) adsorption maxima were greater than those of Cd(2+) for both soils. Acid soils demonstrated much less ability to retain the heavy metals than neutral soils. In the presence of 0.01M CaCl2, adsorption of the metals was much reduced, suggesting Ca(2+) competition for adsorption sites. A considerable amount of Cu(2+) was complexed in the soil solutions, but Cd(2+) complexation was much less evident. The results support an ion exchange mechanism of adsorption in the surface soils, and suggest that precipitation occurs in calcareous subsoils.

78:02K-035
THERMODYNAMICS OF POTASSIUM-CALCIUM AND MAGNESIUM-CALCIUM EXCHANGE REACTIONS ON A KAOLINITIC SOIL CLAY,
Udo, E.J.
Ibadan University, Nigeria, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 556-560, July-August, 1978. 2 fig, 3 tab, 22 ref, 15 equ.

Descriptors: Thermodynamics, Cation exchange, Kaolinite, Potassium, Calcium, Magnesium, Adsorption, Isotherms, Selectivity, Soil profiles.

Thermodynamic parameters derived from experimental results were determined for the potassium-calcium and magnesium-calcium exchange reactions on a kaolinitic soil clay separated from the B horizon of a strongly weathered soil profile. The clay samples were equilibrated at 10 and 30 C with a mixed solution of KCl and CaCl2 for the K-Ca system or MgCl2 and CaCl2 for the Mg-Ca system. For the K-Ca system, the selectivity coefficients were high indicating a greater affinity of the clay for K than for Ca. The high equilibrium constant and the negative values of standard free energy and enthalpy changes for the exchange of Ca for K also revealed a preference of the clay for K relative to Ca ions. In the Mg-Ca system, the exchange isotherms and the low selectivity coefficients indicated a preference of Ca ions for the clay phase. This exchange of Ca for Mg was accompanied by an increase in the free energy and enthalpy changes also pointing to a more stable Ca-clay than Mg-clay.

78:02K-036
PREDICTION OF PHOSPHORUS DIFFUSION FROM FERTILIZER SOURCE,
Hira, G.S., and Singh, N.T.
Punjab Agricultural University, Ludhiana, India, Department of Soils.
Soil Science Society of America Journal, Vol. 42, No. 4, p 561-565, July-August, 1978. 7 fig, 2 tab, 11 ref, 11 equ.

Descriptors: Phosphorus, Diffusion, Fertilization, Diffusivity, Adsorption, Isotherms, Soil chemistry.

Rate of P diffusion from fertilizer applied at the soil surface was studied using Fick's law of diffusion. The diffusion coefficient of P was determined from a knowledge of the tortuosity factor and P adsorption isotherm. Phosphorus diffusion coefficient calculated from Nye's equation did not prove suitable at very low or high concentration of P at the soil surface. The phosphorus diffusion coefficient calculated from experimental data increased linearly with the square root of P concentration applied at the source. Predicted P concentration-distance profiles were very close to the experimental values estimated by employing a sectioning technique.

78:02K-037
PHOSPHATE DESORPTION FROM KAOLINITE SUSPENSIONS,
Bar-Yosef, B., and Kafkafi, U.
Division of Soil Chemistry and Plant Nutrition, Bet Dagan, Israel, The Volcani Center.
Soil Science Society of America Journal, Vol. 42, No. 4, p 570-574, July-August, 1978. 5 fig, 2 tab, 18 ref, 2 equ.

Descriptors: Phosphates, Kaolinite, Activation energy, Hysteresis.

The objective of this work was to study the effect of the desorption method used, equilibration time and the dissolved silica on the desorption of P from kaolinite. Two desorption methods were used: (i) diluting 1% suspensions by various volumes of the same electrolyte, and (ii) immersing a dialysis tube containing 0.25% suspension (+P) in an identical suspension initially free of P. The desorption process in both cases could be divided into a rapid and a slow first-order reaction. The rapid reaction rate constant was similar in both systems (about 4.65 x 0.001/hour at 25 C). The slow reaction constants were 0.3 x 0.001/hour and 1.15 x 0.001/hour for cases (i) and (ii), respectively. The activation energy of the desorption process in case (ii) was 16.2 Kcal/mole for the rapid and 4.8 Kcal/mole for the slow reaction. The amount of silica dissolved from kaolinite due to dilution with 0.01M KCl depended on the dilution ratio and reached 16 mg SiO2/g kaolinite when the suspension was diluted 100-fold. Readsorption of part of the dissolved silica is stipulated to contribute to the fast P desorption process.

78:02K-038
FACTORS AFFECTING DENITRIFICATION IN A SONORAN DESERT SOIL,
Westerman, R.L., and Tucker, T.C.
Oklahoma State University, Stillwater, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 4, p 596-599, July-August, 1978. 4 fig, 3 tab, 6 ref.

Descriptors: Denitrification, Nitrogen, Temperature, Moisture content, Time, Arid climates, Deserts, Carbon, Depth.

Incubation studies were conducted to determine the effect of temperature, moisture content, organic C, soil depth, and time on transformations of added 15NO3(-N) to a Sonoran Desert soil in open and closed systems. In open system studies, increasing temperature from 20 to 37 C, adding organic C, and increasing moisture content from field capacity to saturation increased denitrification losses 16, 22, and 2%, respectively. There were no apparent differences in immobilization of 15NO3(-N) due to temperature, time, moisture content, or soil depth without organic C amendments. However, immobilization of 15NO3(-N) soil with organic C amendments was increased markedly with increased temperature and time, but initial moisture content had little effect. At C/N ratios of 150:1 only traces of 15N appeared in NH4(-N), however, at C/N ratios of 15:1 to 45:1 ammonification and immobilization occurred simultaneously. Closed system investigations with organic C and 15NO3(-N) amendments showed 79% loss in five days with the remaining 21% accumulating as organic-15N. Denitrification losses in open systems with soil moisture contents representative of saturated conditions were 70% of the loss observed under closed systems at the same moisture content.

78:02K-039
SURFACE CHARGE MANIPULATION OF CONSTANT SURFACE POTENTIAL SOIL COLLOIDS: I. RELATION TO SORBED PHOSPHORUS,
Wann, S.S., and Uehara, G.
Hawaii University, Honolulu, Department of Agronomy and Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 4, p 565-570, July-August, 1978. 7 fig, 4 tab, 20 ref, 7 equ.

Descriptors: Colloids, Phosphorus, Cation adsorption, Cation exchange, Soil management, Soil chemistry.

A significant correlation was found between the zero point of charge and the quantity of phosphorus applied to soil material from an Oxisol. Sorbed phosphorus lowered the zero point of charge and increased surface charge density at any pH above the zero point of charge. The soil was treated with 0, 100, 500, and 1,500 ppm P as $(NH_4)_2HPO_4$. For the soil with no added phosphorus, low concentration of monovalent electrolyte and within two pH units of the zero point of charge, diffuse layer theory adequately predicted surface charge. For high electrolyte concentration and high pH, the Stern theory with specific adsorption energy predicted the experimental results. The calculated results indicated charge reversal in the high-phosphorus samples.

78:02K-040
EFFECTS OF SOLUTION CHEMISTRY AND ENVIRONMENTAL CONDITIONS ON AMMONIA VOLATILIZATION LOSSES FROM AQUEOUS SYSTEMS,
Vlek, P.L.G., and Stumpe, J.M.
International Fertilizer Development Center, Florence, Alabama, Agro-Economic Division.
Soil Science Society of America Journal, Vol. 42, No. 3, p 416-421, May-June, 1978. 5 fig, 1 tab, 17 ref, 7 equ.

Descriptors: Nitrogen, Ammonia, Volatility, Rice, Fertilization, Aqueous solutions, Kinetics.

Laboratory studies were conducted to explain the wide variation in reported estimates of ammonia volatilization losses from N-fertilized paddy fields. The ammonia volatilization capacity of a system was found to be equivalent to its alkalinity. In solutions lacking alkalinity, loss of $(NH_4)_2SO_4$ was limited, whereas loss of $(NH_4)_2CO_3$ was essentially complete. Ammonia loss from solution is best described as a consecutive reaction with opposing step. Ammonia volatilization per se followed first-order reaction kinetics. The rate of ammonia volatilization was severely restricted by limiting the movement of air above the water, as is often the case in the laboratory and field studies reported to date. Ammonia volatilization was enhanced by water turbulence and increased exponentially with temperature from almost nil at 0 C to approximately 20 mg N/100 sq cm/5 hours at 46 C.

78:02K-041
CALCIUM-SUPPLYING CHARACTERISTICS OF TWO GYPSUM MATERIALS ON SOUTHEASTERN COASTAL PLAIN SOILS,
Keisling, T.C., and Walker, M.E.
Texas A & M University, Overton, Agricultural Research and Extension Center.
Soil Science Society of America Journal, Vol. 42, No. 3, p 513-517, May-June, 1978. 2 fig, 2 tab, 16 ref.

Descriptors: Gypsum, Calcium sulfate, Peanuts, Granules, Leaching, Particle size, Coastal plains.

Field studies were conducted on two soils to study the manner in which finely and coarsely divided gypsum materials supplied Ca to the soil depth where peanut (Arachis hypogaea L.) fruit absorb Ca. The finely divided material was characterized chemically as $CaSO_4 \cdot 2H_2O$, approximately 72% $CaSO_4$ or 20.2% Ca and physically as having 88% of the particles < 0.25 mm in diameter. The coarsely divided material was characterized chemically as CaSOR, approximately 92% $CaSO_4$ or 26.5% Ca and physically as having 82% with particle diameters < 4.2 mm, but > 0.5 mm. The amount of Ca transported to a given soil depth was found to be related to the magnitude, order, and frequency of rainfall events. The fine gypsum material was found to be more effective in supplying Ca to the soil depth where peanut fruit are absorbing it early in the growing season than the coarser material. Dissolution of gypsum sources consisting of different particle sizes and subsequent transport of Ca into the fruiting zone of peanuts was not always closely related to the total amount of rainfall. Either the finely or coarsely divided gypsum could supply more Ca to the fruiting zone depending on the rainfall pattern.

78:02K-042
COMETABOLISM OF FOREIGN COMPOUNDS,
Golovleva, L.A., and Skryabin, G.K.
Institute of Biochemistry and Physiology of Microorganisms.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 73-85. 6 fig, 11 ref.

Descriptors: Microbial degradation, Soil microbiology, Microorganism, Soil microorganism, Herbicides, Chemical degradation, Environmental control.

The fermentative conversions of many organic substances are closely connected or even depend on oxidation of other compounds--cosubstrates. This dependence is generally called cometabolism. The best known are the cometabolism processes of foreign compounds--xenobiotics, though there are also the examples of cometabolism of natural compounds for instance steroids and terpenes as well as such substrates as xylose, widely spread in nature and easily metabolized. The investigations conducted by the authors proved that conversions of many xenobiotics are possible only under cometabolism conditions. The experiments with introduction of microorganisms into natural water reservoirs did not give positive results. However, the degradation of herbicides was significantly accelerated after introducing cosubstrates. So, analysis of 2,4-D dynamics in waste waters of rice fields has shown that 2,4-D disappeared more quickly if propionate was used as cosubstrate. In this case, the herbicide was not detected in the water in three days; at the same time, about 25% of initial 2,4-D was present in control experiments (without propionate).

78:02K-043
AMMONIA VOLATILIZATION LOSSES FROM FLOODED RICE SOILS,
Mikkelsen, D.S., De Datta, S.K., and Obsemea, W.N.
The International Rice Research Institute, Los Banos, Laguna, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 5, p 725-730, September-October, 1978. 8 fig, 10 ref.

Descriptors: Nitrogen, Volatility, Hydrogen ion concentration, Diurnal, Ammonia, Submerged plants, Fertilization.

The pH of the flood water in rice fields is largely determined by the chemical equilibria that exist between the CO2 balance achieved by the aquatic biota and the various solutes, solids, and gases in the water. Water pH values undergo diurnal changes increasing by midday to values as high as pH 9.5-10 and decreasing as much as 2-3 pH units during the night. The pH of shallow flood water is greatly affected by the total respiration activity of all the heterotrophic organisms and the gross photosynthesis of the species present. Ammonium from fertilizers broadcast into a high pH water are highly susceptible to direct NH3 volatilization losses. Nitrogen losses from fertilizer broadcast into flood water on a fertile, neutral-pH Maahas clay were as high as 20% of the amount applied, but losses varied depending upon water pH, the nitrogen source, rate, time, and method of application. Losses from an acid Luisiana clay, where the flood water was not conducive to algal growth and did not exceed pH 6.8, produced NH3 volatilization losses consistently less than 1% of the total N applied. Placement of N fertilizer in the soil at depths of 10-12 cm reduced NH3 volatilization losses to less than 1% of the total N applied.

78:02K-044
CHEMISTRY OF SNOW MELTWATER: CHANGES IN CONCENTRATION DURING MELTING,
Johannessen, M., and Henriksen, A.
Norsk Institute for Vannforskning, Blindern.
Water Resources Research, Vol. 14, No. 4, p 615-619, August, 1978. 7 fig, 4 tab, 12 ref.

Descriptors: *Snow, *Snowmelt, *Melt water, *Water chemistry, Laboratory tests, On-site investigations, Lysimeters, Snowpacks, Hydrogen ion concentration, Acids.

Over much of Norway a large portion of the yearly precipitation falls as snow, and the pollutants contained in precipitation accumulate in the snowpack to be released during a short period in spring. Atmospheric fallout of sulfur compounds has been estimated to be about 30% of the total deposition in Norway, but fallout on the snow cover is probably considerably smaller. During winters with little or not snowmelt before spring, most of the pollutant load is retained in the snowpack. Laboratory and field lysimeter experiments indicated that 5-80% of the pollutant load is released with the first 30% of the meltwater. The average concentration of pollutants in this fraction is 2-2.5 times the concentration in the snowpack itself. The very first fractions may contain more than 5 times the snowpack itself. These high concentrations may be due to a freeze-concentration process during snow recrystallization and melting in which contaminants accumulate preferentially at the surfaces of ice particles. The resulting increase in the acid concentration of low-buffered water courses occassionally leads to social physiological stress to fish and other aquatic organisms and even to massive fish kills. This process occurs at a time which is critical to the hatching stage of salmonid fish species.

78:02K-045
ELECTRON PROBE MICROANALYSIS OF CALCITE GRAINS CONTAINING PHOSPHORUS IN SOIL,
Qureshi, R.H., and Jenkins, D.A.
Agricultural University, Lyallpur, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 703-705, September-October, 1978. 4 fig, 11 ref.

Descriptors: Calcite, Phosphorus, Chemical analysis, Soil tests, Nutrients, Soil analysis, Analytical techniques.

Calcite, comprising both clastic sand-sized grains and fossil foraminifera inherited from a marine Cretaceous (Gault)clay, was isolated from a haplaquept (gleyic brown calcareous earth) in the United Kingdom and shown by wet chemical analysis to contain an average of 0.3% phosphorus. Electron probe microanalysis indicated that this phosphorus is uniformly distributed within the calcite rather than concentrated as discrete calcium phosphates, and it was concluded that it was biogenic-diagenic rather than pedogenic in origin. Such sources were found to constitute 50-80% of the total soil phosphorus and thus suggested to be relatively available in the upper horizons of the profile.

78:02K-046
THE SPECTROPHOTOMETRIC AND FLUOROMETRIC DETERMINATION OF ALUMINUM WITH 8-HYDROXYGUINOLINE AND BUTYL ACETATE EXTRACTION,
Bloom, P.R., Weaver, R.M., and McBride, M.B.
Minnesota University, St. Paul, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 713-716, September-October, 1978. 2 fig, 3 tab, 11 ref.
(See: 78:07B-018)

78:02K-047
CATION EXCHANGE EQUILIBRIA IN A MIXED SOIL SYSTEM CONTAINING THREE HETEROVALENT CATIONS,
Wiedenfeld, R.P., and Hossner, L.R.
Texas Agricultural Experiment Station, Weslaco, Department of Soil and Crop Sciences.
Soil Science Society of America Journal, Vol. 42, No. 5, p 709-712, September-October, 1978. 4 fig, 1 tab, 12 ref, 15 equ.

Descriptors: Cation exchange, Cations, Chemical reactions, Thermodynamic behavior, Equilibrium, Calcium, Magnesium, Sodium.

Cation exchange equations used with soils have been suitable only for systems containing two cations. Theoretical exchange equilibria relationships for a mixed soil system containing three heterovalent cations: Ca(2+), Mg(2+), and Na(+); were presented. Predictive equations for this tertiary system were derived using solid phase activity coefficients and thermodynamic equilibrium constants for the three binary systems obtained from experimental data. Theoretical cation exchange equilibria described for this tertiary system were in agreement with recognized exchange properties for these three cations. Interactions between two cations as they affect the exchange behavior of a third cation were also predicted. The methods presented are applicable to systems containing any number of heterovalent cations.

78:02K-048
TEMPERATURE AND pH AS LIMITING FACTORS IN LOSS OF NITRATE FROM SATURATED ATLANTIC COASTAL PLAIN SOILS,
Gilliam, J.W., and Gambrell, R.P.
North Carolina State University, Raleigh, Department of Soil Science.
Journal of Environmental Quality, Vol. 7, No. 4, p 526-532, October-December, 1978. 5 fig, 2 tab, 35 ref.

Descriptors: Nitrates, Reduction (chemical), Denitrification, Nitrogen, Water pollution, Groundwater, Atlantic Coastal Plain.

Nitrate reduction rates under water-saturated conditions were determined for two acid Atlantic Coastal Plain topsoils and their acid subsoils at 5, 15, and 25 C. Nitrate reduction readily occurred in subsoils even at pH values of 4.5 when an energy source was added. It was concluded that the acid pH values which commonly occur in Atlantic Coastal Plain soils is not a serious limiting factor in NO3(-) reduction. It was also concluded that the temperatures of 5 to 15 C which exist in the shallow groundwater of the Atlantic Coastal Plain soils during much of the winter limits the rate of NO3(-) reduction and nitrate reduction can occur in these soils at 5 C but the rate is relatively slow and is highly dependent upon the amount of available C. A significant amount of NO3(-) reduction was expected during the winter in poorly drained soils which contain relatively high organic matter contents.

78:02K-049
METABOLISM OF NITROPHENOLS IN FLOODED SOILS,
Sudhakar-Barik, and Sethunathan, N.
Central Rice Research Institute, Cuttack-753006, India, Laboratory of Soil Microbiology.
Journal of Environmental Quality, Vol. 7, No. 3, p 349-352, July-September, 1978. 4 tab, 12 ref.

Descriptors: Organophosphorus compounds, Flooding, Water pollution, Nitrites, Isotope studies, Pollutants.

Nitrophenols (p-,0-, and m-isomers and 2,4-dinitrophenol) disappeared fairly rapidly from flooded alluvial and organic matter-rich acid sulfate (pokkali) soils inoculated with parathion (0,0-diethyl 0,p-nitrophenyl phosphorothioate)-enrichment cultures from the respective soils. Nitrite, one of the reported end-products of nitrophenol (0,0-dimethyl 0,p-nitrophenyl phosphorothioate) metabolism, accumulated only in inoculated alluvial soil, irrespective of the type of nitrophenol added. In an isotope study, ring cleavage of p-nitrophenol leading to carbon dioxide was demonstrated in flooded soils inoculated with parathion-enrichment culture, particularly under stirred conditions. Nitrophenols decomposed also in uninoculated samples of both soil types, though slowly as compared to inoculated soils; but nitrite and carbon dioxide were not formed. Resting cells of a bacterium, Pseudomonas sp. ATCC 29353, readily hydrolyzed parathion and then liberated nitrite from p-nitrophenol. In cell-free suspension, the reaction ceased at the p-nitrophenol stage. In bacterial cultures, parathion was hydrolyzed without proliferation while subsequent degradation of p-nitrophenol involved metabolism leading to bacterial enrichment.

78:02K-050
CATION-EXCHANGE CAPACITY OF CLAY-RICH SOILS IN RELATION TO ORGANIC MATTER, MINERAL COMPOSITION, AND SURFACE AREA,
Martel, Y.A., De Kimpe, C.R., and Laverdiere, M.R.
Agriculture Canada, 2560 chemin Gomin, Sainte-Foy, Quebec, GIV 2J3, Canada.
Soil Science Society of America Journal, Vol. 42, No. 5, p 764-767, September-October, 1978. 1 fig, 7 tab, 16 ref.

Descriptors: Cation exchange, Clay minerals, Clays, Organic matter, Minerology, Soil horizons, Regression analysis, Soil texture.

Regression analyses were used to correlate organic matter, texture and surface area values to the cation-exchange capacity (CEC) or clay-rich soils in the lowlands of Quebec. The Ap, Bg and Cg horizons of 11 Gleysolic soils (Aqu-Suborders) were analyzed for CEC, exchangeable bases and acidity, total and fine clay contents, organic matter, surface area and mineralogical composition. The soils contained illite, chlorite, smectite, and vermiculite in addition to quartz and feldspars. In the Ap horizon, total clay and fine clay contents were better related to CEC than organic matter and surface area. In the Bg and Cg horizons, surface area gave the best correlation with CEC. As calculated by multiple regression equations, CEC values of organic matter increased with depth from 56.5 to 223 meq/100 g, while CEC values of total clay decreased from 37.7 to 22.5 meq/100 g and that of fine clay decreased from 57.5 to 50.7 meq/100 g. Variations in the mineralogical composition, although small, were sufficient to explain nearly 50% of the variations in the CEC.

78:02K-051
ADSORPTION AND EXTRACTABILITY OF MOLYBDENUM IN RELATION TO SOME CHEMICAL PROPERTIES OF SOIL,
Karimian, N., and Cox,F.R.
Pahlavi University, Shiraz, Iran, College of Agriculture, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 757-761, September-October, 1978. 3 fig, 4 tab, 32 ref.

Descriptors: Molybdenum, Adsorption, Soil chemical properties, Soil tests, Iron oxides, Organic matter, Hydrogen ion concentration, Phosphorus.

Adsorption of Mo from aqueous solutions was determined for eight soils from the Atlantic Coastal Plain and Piedmont regions. The data followed the Freundlich isotherm more consistently than the Langmuir. Adsorption increased as the organic matter and/or Fe oxide contents of the soils increased. Adsorption from an aqueous solution that was initially 0.3 mM Mo (AdMo) also was determined on 32 soils collected from the regions. The AdMo level was positively correlated with Fe oxide and organic matter contents and negatively correlated with pH and P levels. The level of Mo extracted with acid ammonium oxalate (Grigg Mo) and an anion exchange resin (resin Mo) were also determined and related to soil chemical properties and a lime treatment. Grigg Mo was positively correlated with amorphous and free Fe oxide by oxalate. Resin Mo was positively correlated with pH but not with other soil properties. Incubating soils with $CaCO_3$ increased the level of resin Mo.

78:02K-052
CHEMICAL CHARACTERIZATION OF THE GASEOUS AND LIQUID ENVIRONMENTS OF SUBSURFACE DRAIN SYSTEMS,
Meek, B.D., Grass, L.B., and MacKenzie, A.J.
Imperial Valley Conservation Research Center, Brawley, California.
Soil Science Society of America Journal, Vol. 42, No. 5, p 693-698, September-October, 1978. 3 fig, 6 tab, 14 ref.

Descriptors: Chemical precipitation, Subsurface drains, Subsurface drainage, Aeration, Iron, Manganese, Oxygen, Drainage water, Oxidation, Reduction (chemical).

Chemical composition of subsurface drain effluents was determined in the field as a function of location (various depths and soil textures), entry point of the solution into the drainpipe, and distance from outlet (with or without a water trap). Liquid samples were analyzed for Fe, Mn, NO_3-N, HCO_3, organic carbon, electrical conductivity, pH, and dissolved oxygen, and gas samples were analyzed for O_2 and CO_2.

78:02K-053
BIOLOGICAL HYDROLYSIS OF PARATHION IN NATURAL ECOSYSTEMS,
Sudhakar-Barik, and Sethunathan, N.
Central Rice Research Institute, Cuttack-753006, India, Laboratory of Soil Microbiology.

Journal of Environmental Quality, Vol. 7, No. 3, p 346-348, July-September, 1978. 5 tab, 11 ref.

Descriptors: Organophosphorus compounds, Flooding, Hydrolysis, Water pollution.

Parathion (0,0-diethyl 0,p-nitrophenyl phosphorothioate) was applied to flooded soils and to water and sediment river, lake, and pond samples at 15-day intervals. While p-nitrophenol (0,0-dimethyl 0,p-nitrophenyl phosphorothioate), the hydrolysis product of parathion, was not detected, even at the end of 12 days after the first addition, it was detected in all samples within 6 hours after two or three additions of the insecticide. Enrichment cultures from the samples of different ecosystems lost their ability to hydrolyze parathion following autoclaving, suggesting microbial participation in parathion hydrolysis.

78:02K-054

EXTRACTABILITY OF CADMIUM, COPPER, NICKEL, AND ZINC BY DOUBLE ACID VERSUS DTPA AND PLANT CONTENT AT EXCESSIVE SOIL LEVELS,

Korcak, R.F., and Fanning, D.S.
United States Department of Agriculture, Science and Education Administration, Fruit Laboratory, Beltsville Agricultural Research Center-West, Beltsville, Maryland.
Journal of Environmental Quality, Vol. 7, No. 4, p 506-512, October-December, 1978. 1 fig, 9 tab, 18 ref.
(See 78:02I-032)

78:02K-055

INFLUENCE OF THE CHEMICAL FORM OF MERCURY ON ITS ADSORPTION AND ABILITY TO LEACH THROUGH SOILS,

Hogg, T.J., Stewart, J.W.B., and Bettany, J.R.
Saskatchewan University, Saskatoon, Saskatchewan, Canada, Institute of Pedology.
Journal of Environmental Quality, Vol. 7, No. 3, p 440-445, July-September, 1978. 2 fig, 4 tab, 19 ref.

Descriptors: Mercury, Adsorption, Leaching, Volatility, Sewage effluents, Sewage disposal, Irrigation, Soil analysis.

The adsorption of Hg by two soils, differing in chemical and physical characteristics, indicated that both methyl mercuric chloride (MMC) and phnyl mercuric acetate (PMA) and mercuric chloride ($HgCl_2$) followed the linear form of the Langmuir adsorption isotherm. The highest adsorption maxima for all Hg compounds were found for the soils which had the higher organic matter content and clay content. Adsorption maxima increased in the order MMC < PMA < $HgCl_2$. A two-rate effluent leaching experiment was conducted utilizing undisturbed soil cores of the same two soils and the same three Hg compounds (labeled with ^{203}Hg) which were applied uniformly to the top 0-10 cm of each column. In contrast to the movement of other cations in the effluent and soil, even at the higher irrigation rate, none of the applied Hg was found to move below the 10- to 20-cm soil layer. The lack of movement of Hg and the high adsorption maxima was a consequence of the strong binding between Hg compounds and soil. The inability of weak chemical extractants ($CaCl_2$, NH_4OAC, DTPA, EDTA) to remove significant quantities of Hg confirmed this hypothesis. Seven to 31% of the applied Hg was lost from the columns during the experiment presumably by volatilization.

78:02K-056

SEASONAL VARIATION IN PCO_2 AND ^{13}C CONTENT OF SOIL ATMOSPHERE,

Rightmire, C.T.
United States Geologic Survey, Idaho National Engineering Laboratory, Idaho Falls.
Water Resources Research, Vol. 14, No. 4, p 691-692, August, 1978. 1 fig, 9 ref, 2 equ.

Descriptors: Soil gases, Soil environment, Carbon dioxide, Seasonal, Groundwater recharge, Artificial recharge.

Soil carbon dioxide is the dominant source of dissolved inorganic carbon in recharging waters. Samples of soil CO_2 were collected to determine if seasonal variations in ^{13}C content parallel those previously observed for PCO_2. Significant seasonal variations in both PCO_2 and ^{13}C content were observed. The data presented in this paper indicated that the studies of groundwater carbonate chemistry require knowledge of the season during which major recharge occurs.

78:02K-057
LONG-TERM DENITRIFICATION STUDIES IN SOILS FERTILIZED WITH (15NH4)2SO4(1),
Focht, D.D., and Stolzy, L.H.
California University, Riverside, Department of Soil and Environmental Sciences.
Soil Science Society of America Journal, Vol. 42, No. 6, p 894-898, November-December, 1978. 6 fig, 1 tab, 31 ref, 3 equ.

Descriptors: Denitrification, Nitrogen, Nitrates, Nitrogen cycle, Soil gases, Air pollution, Lysimeters, Isotope studies, Fertilization.

A 2-year study was conducted in lysimeters containing four different soils with successive summer and winter crops of corn and barley, respectively. The crops were fertilized with (15NH4)2SO4 at application rates equivalent to 134, 108, 415, and 440 Kg N/ha for the respective summer 1973, winter 1974, summer 1974, and winter 1975 crops. The frequency of 15N dinitrogen samples was higher in the summer and high at the lower fertilizer rates, while the reverse was true for NO3(-) concentrations in leach water and N2O concentrations in the soil profile. Emissions of N2O from soil, even where the higher concentrations were observed, were low in terms of N losses with the greatest mass emission at any time amounting to 6.5 g/ha over a 1-day period. Nitrogen gas emissions over a 1-week period in one instance were estimated at 5.2 kg N/ha: it was observed that this amount could be generated from low (1 ppm or less) concentrations of N2O.

78:02K-058
EXCHANGE ADSORPTION OF TRACE QUANTITIES OF CADMIUM IN SOILS TREATED WITH CALCIUM AND SODIUM: A REAPPRAISAL,
Milberg, R.P., Brower, D.L., and Lagerwerff, J.V.
Agricultural Environmental Quality Institute, Beltsville Agricultural Research Center, Beltsville, Maryland 20705.
Soil Science Society of America Journal, Vol. 42, No. 6, p 892-894, November-December, 1978. 2 tab, 4 ref, 1 equ.

Descriptors: Cation exchange, Cation adsorption, Cadmium, Calcium, Sodium, Organic matter.

This paper presents a reevaluation and revision of the data on Ca-Cd and Na-Cd exchange in three soils originally presented in an earlier paper (Lagerwerff and Brower, Soil Sci. Am. Proc. 36:734-737). Cadmium was selectively adsorbed over Ca in Cecil, Winsum, and Yolo soils with up to 1.7% of the total cation exchange capacity occupied by Cd. Selectivity was greatest in Yolo and least in Cecil. Effects of undissociated Cd in solution were minor. Separation factors decreased with increasing exchangeable Cd. Reexamination of Cd-Na exchange revealed that anomalous earlier results were due to the dispersion of organic matter during treatment with Na2CO3 in the preparation of Na-saturated soils. Na-Cd exchange was normal where organic matter loss was prevented.

78:02K-059
SERIOUS INTERFERENCES IN THE DETERMINATION OF TRACE METALS IN SOILS BY FLAME AND FLAMELESS ATOMIC ABSORPTION SPECTROMETRY,
Mubarak, A., Hageman, L., Howald, R.A., and Woodriff, R.
Montana College of Mineral Science and Technology, Butte, Department of Chemistry.
Soil Science Society of America Journal, Vol. 42, No. 6, p 889-891, November-December, 1978. 5 tab, 14 ref.

Descriptors: Trace elements, Spectrometers, Chemical analysis, Soil chemistry, Absorption.

Negative interfering effects on the carbon rod atomizer (CRA) absorbances of Mn, Fe, and Ni were found to occur in the presence of the chlorides of the major cations (Ca, Mg, Na) in the soil solution. These interferences were corrected either by precipitation of the chlorides with silver nitrate or by incorporating a relatively high level of sulfuric or nitric acid into the sample volume.

Magnesium ion, irrespective of the associated anion, was found to lower the Cd signal on the CRA. High concentrations of $MgSO_4$ caused lowering of the Mn signal when using air-acetylene flame. This lowering effect of $MgSO_4$ was avoided upon using N_2O-acetylene flame. No interferences were noticed for Mn and Zn when using the constant temperature furnace developed at Montana State University.

78:02K-060
SURFACE CHARGE MANIPULATION IN CONSTANT SURFACE POTENTIAL SOIL COLLOIDS: II. EFFECT ON SOLUTE TRANSPORT,
Wann, S.S., and Uehara, G.
Hawaii University, Honolulu, Department of Agronomy and Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 6, p 886-888, November-December, 1978. 6 fig, 2 tab, 6 ref, 1 equ.

Descriptors: Ion transport, Ion exchange, Colloids, Nutrient removal, Potassium, Phosphorus, Isotherms.

Potassium breakthrough curves from soil columns containing samples collected from an oxic horizon of a Typic Torrox shifted to the right as the sample was treated with increasing levels of P. The shift in the breakthrough curve was significantly related to a lowering of the zero point of charge. The lowering of the zero point of charge was in turn related to levels of applied P. The anion accompanying K also had a marked effect on the position of the breakthrough curve. When the accompanying anion was Cl, S, and P respectively, the K concentration in the effluent attained one-half of influent concentration at 4.25, 5.30, and 8.20 pore volumes.

78:02K-061
FIELD MEASUREMENT OF DENITRIFICATION: I. FLUX OF N_2 AND N_2O,
Rolston, D.E., Hoffman, D.L., and Toy, D.W.
California University, Davis, Department of Land, Air and Water Resources.
Soil Science Society of America Journal, Vol. 42, No. 6, p 863-869, November-December, 1978. 7 fig, 3 tab, 16 ref, 3 equ.

Descriptors: Denitrification, Nitrogen, Nitrogen cycle, Measurement, Soil gases, Diffusion, Soil moisture, Soil temperature, Water pollution.

The objective of the research reported in this paper was to measure denitrification in a field soil directly from the fluxes of N_2 and N_2O at the soil surface at a high and low soil temperature, at two water contents near saturation, and at three levels of C input (cropped, uncropped, and manure). The research was conducted on small one-m^2 field plots because of the large cost of $NO_3^{(-)}$ fertilizer tagged with high enrichments of ^{15}N.

78:02K-062
DETERMINATION OF THE APPARENT DISPERSION COEFFICIENT OF SOLUTES IN UNSATURATED SOIL,
Paetzold, R.F., and Scott, H.D.
United States Department of Agriculture, Soil Conservation Service, National Soil Survey Laboratory, Lincoln, Nebraska 68508.
Soil Science Society of America Journal, Vol. 42, No. 6, p 874-877, November-December, 1978. 3 fig, 1 tab, 14 ref, 16 equ.

Descriptors: Dispersion, Solutes, Diffusion, Convection, Unsaturated flow, Radioisotopes, Pesticides, Herbicides, Soil chemistry.

A method for determining the apparent dispersion coefficient of a solute in unsaturated soils at relatively low soil water flow rates was presented. Two soil cores with different initial water contents were joined and water allowed to flow between the soil cores for a specified time interval. The distribution of a radioactively tagged solute, initially present in one of the soil cores, was subsequently determined by freezing the cores in liquid air, sectioning the soil with a refrigerated microtome, and analyzing the soil sections for solute content using liquid scintillation techniques. Apparent dispersion coefficients could be determined either with or against the water flow. The solutes used in this study were tritiated water, chloride, and metribuzin (a herbicide).

78:02K-063
A UNIVERSAL DIMENSIONLESS PHOSPHATE ADSORPTION ISOTHERM FOR SOIL,
Shayan, A., and Davey, B.G.
Arya-Mehr University of Technology, Isfahan, Iran.
Soil Science Society of America Journal, Vol. 42, No. 6, p 878-882, November-December, 1978. 3 fig, 1 tab, 20 ref, 5 equ.

Descriptors: Adsorption, Phosphates, Isotherms, Kaolinite, Chemical potential, Fertilizers, Soil chemistry.

A unique dimensionless phosphate adsorption isotherm, covering the solution concentration range 0.000001 to 0.1M P, which has been found to fit 17 materials including 15 soils, pure kaolinite and amorphous $Al(OH)_3$, was derived. The soils shown to fit the isotherm included chronic luvisols, pellic vertisols, calcic luvisols, a tropeptic eutrorthox, a volcanic ash soil from New Zealand, and a number of English soils. The necessary parameters to derive a complete adsorption isotherm for a particular soil from the universal isotherm, required three adsorption experiments in the high concentration range (0.000001 to 0.0001M P) to define the linear portion of the isotherm and the critical concentration. Three other determinations in the range 0.000001 to 0.0001M P were needed to obtain the Freundlich isotherm from the data after correction for the effect of the linear region of the isotherm at high concentration. The advantage of this universal isotherm over conventional isotherms, is that it requires less experimental work to define and is applicable over a wide range of P concentrations such as might be found surrounding a fertilizer granule.

78:02K-064
CHLORIDE AS A FACTOR IN MOBILITIES OF Ni(II), Cu(II), AND Cd(II) IN SOIL,
Doner, H.E.
California University, Berkeley, Department of Soils and Plant Nutrition.
Soil Science Society of America Journal, Vol. 42, No. 6, p 882-885, November-December, 1978. 5 fig, 3 tab, 15 ref, 4 equ.

Descriptors: Trace elements, Metals, Chlorides, Adsorption, Ion transport, Leachate, Chemical analysis, Soil analysis, Water pollution, Laboratory tests.

An investigation was undertaken to study the mobility of chloro-complexes of Ni(II), Cu(II), and Cd(II) through soil. Soil columns were leached with 0.1, 0.2, 0.3, or 0.5M NaCl or $CaClO_4$ solutions, each containing 10 microgram/ml Ni(II), Cu(II), or Cd(II). Sodium perchlorate solutions were used as a comparison with CaCl at the same ionic strength since perchlorate is not considered to form complexes with the metals. Leachates from columns and soils were collected and analyzed. Mobility of all metals tested in chloride solutions was from 1.1 to 4 times greater than that in $ClO_4(-)$ solution. Chloride increased the mobility of Cd(II) the most which corresponds to its having the largest stability constants. Copper (II) was slowest to appear in the leachate and was strongest adsorbed as evidenced by analysis of soil by digestion with either 4N HNO_3 or acidified NH_2OH-HCl. These results showed that Cl(-) has a marked effect on the mobility of Cd(II) and, to a lesser extent, Ni(II) and Cu(II).

78:02K-065
A KINETIC STUDY OF THE $CaCO_3$ PRECIPITATION REACTION,
Gilmour, J.T., Shirk, K.S., Ferguson, J.A., and Griffis, C.L.
Arkansas University, Fayetteville, Department of Agronomy.
Agricultural Water Management, Vol. 1, No. 3, p 253-262, November, 1978. 2 fig, 4 tab, 10 ref, 5 equ.

Descriptors: Chemical precipitation, Chemical reactions, Soil chemistry, Calcium carbonate, Magnesium carbonate, Kinetics, Water management (applied), Mathematical models, Rice.

In order to develop water management practices which would minimize localized precipitation of Ca and Mg carbonates on Arkansas' rice fields, a description of the precipitation reaction was needed. Waters studied were prepared solutions which contained varying amounts of $Ca(HCO_3)_2$, $Mg(HCO_3)_2$ and/or $MgCl_2$, and subterranean water samples collected in the field. These waters were monitored for Ca and Mg loss due to carbonate precipitation under unseeded, spontaneous conditions. The rate of Ca loss from solution was adequately described by first order kinetics where Ca was the rate determining ion. An empirical equation was developed which showed that the rate constant could be calculated from temperature and solution composition data. An evaluation of the rates of Ca and Mg loss from solution for the experimental periods studied showed that Mg losses were small when compared to Ca losses.

78:02K-066
THE NITROGEN-15 ABUNDANCE IN A WIDE VARIETY OF SOILS,
Shearer, G., Kohl, D.H., and Chien, S-H.
Washington University, St. Louis, Missouri, Center for the Biology of Natural Systems.
Soil Science Society of America Journal, Vol. 42, No. 6, p 899-902, November-December, 1978. 1 fig, 6 tab, 13 ref, 2 equ.

Descriptors: Nitrogen, Soil chemical properties, Fertilizers, Environment, Soil chemistry, Sampling, Correlation analysis.

One hundred thirty-nine soil samples from 20 states were analyzed for 15N abundance. Soil characteristics and environmental conditions at the sampling sites varied widely. The total N of surface soil samples had a mean delta 15N value (per mill 15N excess) slightly but significantly higher than the mean value for soils collected from deeper layers, although the relationship between delta 15N and soil depth was not consistent from location to location. Differences among mean delta 15N values for the total N of soil samples collected from cropland, pasture, uncultivated land (with native herbs), and forest were not striking. There was no systematic effect of variation in the rate of application of N fertilizer on the delta 15N of the total N of soils. The mean delta 15N value of surface soils, with respect to atmospheric N, was +9.22 and the standard deviation was 2.10 delta 15N units. The range within which 90% of the samples fell was +5.1 to +12.3 delta 15N units. Less than half of the variation among the soils in delta 15N of the total N could be accounted for by differences in environmental variables or soil characteristics.

78:02K-067
NITROGEN MINERALIZATION AND DENITRIFICATION IN ORGANIC SOILS,
Guthrie, T.F., and Duxbury, J.M.
Cornell University, Ithaca, New York, Department of Soil Organic Chemistry.
Soil Science Society of America Journal, Vol. 42, No. 6, p 908-912, November-December, 1978. 1 fig, 6 tab, 13 ref.

Descriptors: Nitrogen, Denitrification, Organic soils, Nitrates, Leachate, Laboratory tests.

The quantities of N mineralized when columns of Histosols were incubated at field capacity for period up to 28 days corresponded to 500-600 kg N/ha per year without correction for N lost by denitrification. An absorption train utilizing molecular sieve 5A to collect N2O was used in denitrification experiments. Under an argon stream, 52-53% of the added NO3(-)-N was recovered as N2O, whereas the maximum concentration of N2O accumulating in the headspace of closed vessels amounted to 65% of the added NO3(-)-N. The quantity of N2O either collected or accumulating in the headspace was reduced to 15-41% of the NO3(-)-N denitrified when a second addition of NO3(-) was made to the soils. Denitrification occurred in both drained and flooded soil columns amended with NO3(-). The N2O recovered ranged from 2.5-9% and 9-19% of the NO3(-)-N denitrified in the drained and flooded columns, respectively. From 78-98% of the N2O was recovered in leachate from the flooded columns and the corresponding range for the drained columns was 11-52%.

78:02K-068
NITRATE REDUCTION TO AMMONIUM IN ANAEROBIC SOIL,
Buresh, R.J., and Patrick, W.H.
Louisiana State University, Baton Rouge, Center for Wetland Resources.
Soil Science Society of America Journal, Vol. 42, No. 6, p 913-918, November-December, 1978. 3 fig, 3 tab, 32 ref.

Descriptors: Nitrates, Reduction (chemical), Anaerobic conditions, Denitrification, Nitrogen, Oxidation-reduction potential, Soil chemistry.

The objectives of this study were: (i) to compare the influence of various C substrates upon the extent of NO3(-) reduction to NH4(+) relative to denitrification in anaerobic soil, and (ii) to determine the significance of NO3(-) conversion to NH4(+) and organic N in unamended anaerobic soil. Ammonium accumulates by way of mineralization under anaerobic conditions, consequently 15N-labelled NO3(-) was employed to distinguish between soil and NO3(-) -derived NH4(+). It was concluded that transformation of significant amounts of NO3(-) to NH4(+) and organic N required intensely reduced soil conditions. The reaction was apparently not suppressed by NH4(+). Evidence indicated that NO3(-) was reduced to NH4(+) by a nonassimilatory pathway in which NO3(-) functioned as a terminal electron acceptor.

78:02K-069
PHOSPHORUS SUPPLYING CAPACITIES OF PREVIOUSLY HEAVILY FERTILIZED SOILS,
Novais, R., and Kamprath, E.J.
Universidade Federal de Vicosa, Brazil, Department of Soils.
Soil Science Society of America Journal, Vol. 42, No. 6, p 931-935, November-December, 1978. 3 fig, 7 tab, 22 ref.

Descriptors: Phosphorus, Soil tests, Soil chemical properties, Fertilizers, Nutrient removal, Chemical analysis, Soil analysis, North Carolina.

Four Coastal Plain soils and one Piedmont soil heavily fertilized in the past were intensively cropped in greenhouse pots to determine changes in extractable soil P as measured by North Carolina, Bray I and Olsen extractants. Slopes relating changes in extractable P with P removed by cropping were very similar for the three sandy soils. Changes in extractable P with the North Carolina and Bray I extractants were correlated with P buffer capacity, % clay, and soil surface area. The principal source of P removed by cropping was NH4F-P in sandy Coastal Plain soils; NH4F-P and NaOH-P supplied equal amounts in the clayey Piedmont soil. Sandy Coastal Plain soils which originally contained more than 74 ppm North Carolina extractable P and 71 ppm Bray I extractable P supplied 82 to 108 kg P/ha to nine crops of pearl millet (Pennisetum americanum, cv. Gahi-1).

78:02K-070
CATION EXCHANGE EQUILIBRIA IN FLORIDA AND INDIANA HISTOSOLS,
Baligar, V.C., Barber, S.A., and Myhre, D.L.
Purdue University, West Lafayette, Indiana.
Soil Science, Vol. 126, No. 2, p 109-117, August, 1978. 2 fig, 4 tab, 31 ref, 8 equ.

Descriptors: Cation exchange, Organic soils, Cation adsorption, Selectivity, Potassium, Isotherms, Soil chemistry, Soil chemical properties, Florida, Indiana.

Ion exchange equilibria have been investigated in mineral soils, but little information is available for organic soils. This investigation was undertaken to characterize the cation selectivity of differing histosols and to determine a suitable cation exchange equation to express the ion selectivity in these soils. Four histosols were incubated for 3 weeks with 5 levels of K and Rb. At the end of incubation, ions in soil solution and on the adsorbed phase were determined. All soils had a greater fraction of Ca in the exchange phase than in solution, whereas with Mg, Mn, K, and Rb, the reverse occurred. Increasing K and Rb saturation was related to an increase in selectivity coefficient for Rb-K. On the Pahokee muck soils, Rb was adsorbed more tightly than K, where the amount of Rb added exceeded 1.0 me/100 g of soil. On the Edwards muck soil, Rb was adsorbed preferentially to K at all levels. Magnesium was adsorbed preferentially to Ca on the Edwards muck soil, but not on the Pahokee soils. Selectivity coefficients for K-Ca were calculated using the Kerr, Gapon, Krishnamoorthy and Overstreet, Vanselow, and Scheffer and Ulrich equations. In all but the Scheffer and Ulrich equation, the selectivity coefficient decreased as K and Rb were increased. In the latter it increased. No equation satisfactorily described the system.

78:02K-071
NITROGEN AND CHLORIDE LEACHING IN A SANDY FIELD PLOT,
Cameron, D.R., Kowalenko, C.G., and Ivarson, K.C.
Soil Research Institute, Agriculture Canada, Ottawa, Ontario K1A 0C6.
Soil Science, Vol. 126, No. 3, p 174-180, September, 1978. 3 fig, 2 tab, 15 ref.

Descriptors: Nitrogen, Chloride, Leaching, Leachate, Environmental sanitation, Denitrification, Nitrates.

In field experiments conducted on a well-drained, sandy soil, 59 and 99 percent of the added chloride was lost by leaching from the 0-75-cm layer by the end of October in 1975 and 1976, respectively. Chloride losses were proportional to total precipitation. The average spring-to-fall rates of N losses for 1975 and 1976 were 0.65 and 1.45 kg N/ha/day, and were directly proportional to N fertilization rates of 120 and 255 kg/ha, respectively. NO3-N and Cl tended to show similar distribution patterns in the profile, and ratios of Cl to NO3-N indicated predominant leaching rather than denitrification losses. N and Cl losses appeared to be associated with irregular, diffuse bulges, rather than with distinct peaks of solute moving steadily downward.

78:02K-072
INFLUENCE OF PHOSPHORUS ON ZINC, IRON, MANGANESE, AND COPPER UPTAKE BY PLANTS,
Wallace, A., Mueller, R.T., and Alexander, G.V.
California University, Los Angeles, Laboratory of Nuclear Medicine and Radiation Biology.
Soil Science, Vol. 126, No. 6, p 336-341, December, 1978. 3 tab, 28 ref.

Descriptors: Nutrient removal, Nutrients, Zinc, Iron, Manganese, Copper, Phosphorus, Plant growth, Beans.

Five cultivars of soybeans (Glycine max. L.) and a bush bean (Phaseolus vulgaris L. cv "Improved Tendergreen") were grown in nutrient solutions with different P levels, solution pH, and, in the case of bush bean, at different Fe levels. The objective of the experiments was to obtain more definitive answers to problems of P-induced Zn and Fe deficiencies. Differential solution pH, obtained by adding solid phase CaCO3 to the nutrient solution (about pH 7) vs. a regular solution (about pH 4-5), indicates that pH is very important in the effects obtained. At high pH, increasing solution P decreased the leaf, stem, and root concentrations of Zn, Mn, and Cu in soybeans. Iron was decreased in roots, but not in leaves and stems. In contrast, at low pH, increasing the P resulted in more Zn, Mn, and Cu but less Fe in leaves, stems, and roots. Results with bush beans were only slightly different from those with soybeans, and the Zn-P effects were modified slightly by Fe levels. High P decreased Fe transport to leaves in bush beans at low and high pH, but only at the high Fe level.

78:02K-073
EFFECT OF SULFATE IONS ON THE STABILITY AND EXCHANGE CHARACTERISTICS OF AN ALUMINUM-INTERLAYERED WYOMING BENTONITE,
Singh, S.S., and Miles, N.M.
Soil Research Institute, Research Branch, Agriculture Canada, Ottawa, Ontario K1A 06C, Canada.
Soil Science, Vol. 126, No. 6, p 323-329, December, 1978. 2 fig, 4 tab, 16 ref.

Descriptors: Bentonite, Suspension, Clay minerals, Sulfates, Chemical precipitation, X-ray diffraction, Chemical properties, Soil chemistry.

Aluminum-interlayered, Wyoming bentonite suspensions, containing different amounts of precipitated Al, were equilibrated with SO4 solutions at different concentrations. The amount of Al precipitated as Al-hydroxy complex was 400, 550, and 750 me/100 g clay, and the concentration of SO4 in solution as 10, 20, and 30 me/l. On equilibration, the hydroxy-Al interlayer precipitate in the Wyoming bentonite reacted with SO4 ions, and a neutral precipitate of aluminum hydroxy sulfate was formed. Heating the Wyoming bentonite to 700°C resulted in complete collapse, showing that the precipitate was no longer present in the interlayer space. A crystalline compound of aluminum hydroxy sulfate was formed as evidenced by x-ray diffraction patterns. In the case of Al-interlayered, Wyoming bentonite suspensions that were not equilibrated with SO4 solution, the Al-hydroxy precipitate remained in the interlayer space and blocked the exchange sites. Treatment of these samples with SO4 solutions resulted in an increase of exchange capacity that was concentration-dependent.

78:02K-074

EVALUATION OF AMMONIUM RELEASE BY ALKALINE PERMANGANATE EXTRACTION AS AN INDEX OF SOIL NITROGEN AVAILABILITY,

Stanford, G.
United States Department of Agriculture, Science and Education Administration,
Northeastern Region, Biological and Waste Management and Soil Nitrogen Laboratory,
Beltsville, Maryland 20705.
Soil Science, Vol. 126, No. 4, p 244-253, October, 1978. 1 fig, 4 tab, 27 ref.

Descriptors: Nitrogen, Chemical analysis, Soil chemistry, Organic matter, Laboratory tests, Hydrolysis, Oxidation.

The relation of potentially mineralizable soil nitrogen, NO, to hydrolytic and oxidative release of NH4-N from soil organic matter by extraction with alkaline permanganate was investigated using 62 soils representing several major agricultural regions in the United States. The NH4-N was recovered by steam-distilling 1-g samples of soil during extraction for 4 min with several concentrations of NaOH and KMn04 in different combinations. The same concentrations of NaOH, without KMn04, were used to determine amounts of NH4-N released by hydrolysis (B) during steam distillation. Oxidative release was estimated as the difference between total NH4-N produced during alkaline permanganate extraction (BOx) and that derived by NaOH distillation. With few exceptions, correlations of NO with BOx were as good as, or better than, simple correlations of NO with B or (BOx - B). Thus, the extra effort required for separate NaOH and NaOH-KMn04 extractions did not appear to be justified. It was concluded that the alkaline permanganate methods thus far reported by various investigators, as well as modifications evaluated in this study, offer a less precise and reliable basis for predicting NO than does acid permanganate extraction for measuring oxidative release of NH4-N.

78:02K-075

OXIDATIVE RELEASE OF POTENTIALLY MINERALIZABLE SOIL NITROGEN BY ACID PERMANAGANATE EXTRACTION,

Stanford, G., and Smith, S.J.
United States Department of Agriculture, Agricultural Research Service, Biological
Waste Management and Soil Nitrogen Laboratory, Beltsville, Maryland 20705.
Soil Science, Vol. 126, No. 4, p 210-218, October, 1978. 6 fig, 2 tab, 13 ref.

Descriptors: Nitrogen, Chemical analysis, Soil tests, Organic matter, Soil chemistry, Laboratory tests, Oxidation.

The relation of potentially mineralizable soil nitrogen, NO, to the oxidative release of NH4-N from soil organic matter during extraction with acid KMn04 was investigated, using 62 soils. Included in the study were members of 8 soil orders comprising 43 noncalcareous and 19 calcareous soils. Soils were extracted with 1 N H2SO4 solutions of 0.05 and 0.1N KMn04 (HOx) and with 1 N H2SO4 (H) alone for 1 h at room temperature, and amounts of NH4-N released were determined. The expression HOx - H denotes the quantity of NH4-N released owning to partial oxidation of soil organic matter. Later, a more direct and simpler procedure for determining oxidative NH4-N release was adopted, in which soils were preextracted with 1 N acid, and the soil residues were extracted with acidic KMn04. Regression equations that may be useful in predicting NO from the oxidative release of NH4-N were developed. Amounts of NH4-N released by oxidation with 1 N H2SO4 solutions of 0.05 and 1.0 N KMn04, respectively, were approximately one-third and one-half of NO. It was concluded that the NH4-N was derived from oxidation of the soil organic N fraction most readily susceptible to biological mineralization.

SECTION XII

WATER SUPPLY AUGMENTATION AND CONSERVATION

WATER YIELD IMPROVEMENT (GROUP 03B)

78:03B-001
ANALYSIS OF FALLOW-FARMING SYSTEMS IN SEMI-ARID AFRICA USING A MODEL TO SIMULATE THE HYDROLOGIC BUDGET,
Hall, A.E., and Dancette, C.
California University, Riverside, Department of Plant Sciences.
Agronomy Journal, Vol. 70, No. 5, p 816-823, September-October, 1978. 10 fig, 4 tab, 16 ref, 7 equ.

Descriptors: Semiarid climates, Fallowing, Model studies, Simulation analysis, Hydrologic budget, Evaporation, Water conservation, Soil moisture, Root system.

A model was developed to predict bare soil evaporation, crop water use, and the distribution of water in the soil. Comparisons with hydrologic budget data obtained in the field with bare soil, cowpeas (Vigna unguiculata (L.) Walp.), and millet (Pennisetum typhoides (Burm. f.) S. and W.) indicated that the models performed adequately for the conditions and objectives of the study. Simulations of annual fallow, predicted that the amounts of water conserved in the soil would rapidly decrease with decreases in annual rainfall. The simulations predicted that substantial quantities of water may be conserved in the soil by partial fallow during wetter years. More soil moisture would be conserved with the shorter cycle variety, but the longer cycle variety would have greater need for this moisture in this climatic zone during dry years, indicating a possible advantage of rotations involving short cycle, and long cycle crops. The simulations predicted that present varieties may only use a small proportion of the moisture that may be stored below 150 cm depth in the soil by partial fallow, indicating a possible need for developing varieties with faster growing, deeper, root systems.

SECTION XIII

WATER SUPPLY AUGMENTATION AND CONSERVATION

USE OF WATER OF IMPAIRED QUALITY (GROUP 03C)

78:03C-001
TESTING SALT TOLERANCE VARIABILITY AMONG TALL WHEATGRASS LINES,
Shannon, M.C.
United States Salinity Laboratory, United States Department of Agriculture,
4500 Glenwood Drive, Riverside, California 92501.
Agronomy Journal, Vol. 70, No. 5, p 719-722, September-October, 1978. 1 fig,
3 tab, 22 ref.

Descriptors: Wheatgrass, Salt tolerance, Varieties, Variability, Plant breeding, Plant physiology.

In the present study a screening procedure was evaluated to determine its usefulness in detecting variation among introductions of tall wheatgrass (Agropyron elongatum (Host) Beauv.). In greenhouse sand flats, 32 lines of tall wheatgrass were established and subjected to stepwise increases in salinity up to 765 meq/liter or until severe leaf damage resulted. The lines were classified into five groups based on relative leaf damage and recovery rates from salt treatment. Repeating the screening procedure on seven each of the most tolerant and most sensitive lines reaffirmed the results of the first screening. Mineral analyses indicated that tolerance was associated with restricted accumulation of Na, Ca, and Cl in the shoots. Proline and soluble sugars contributed to osmotic adjustment at high salinities, but sensitive and tolerant lines did not differ in proline content. This screening technique appeared to discriminate between lines with different ion transport properties and different salt tolerances. The sensitive and tolerant lines identified may be beneficial in future breeding and physiological studies.

78:03C-002
ROOT GROWTH ALONG PLEXIGLAS SURFACES BY SUGARCANE UNDER DIFFERENT SOIL SALINITY CONDITIONS,
Gerard, C.J.
Texas A & M University, Vernon, Texas Agricultural Experiment Station.
Agronomy Journal, Vol. 70, No. 4, p 639-643, July-August, 1978. 7 fig, 1 tab,
12 ref.

Descriptors: Root development, Salinity, Moisture stress, Growth stages, Sugarcane, Plant growth, Saline soils, Crop response, Saline water.

Root growth of sugarcane (Saccharum officinarum L.) in soils irrigated with waters with electrical conductivities of 1.1, 5.0, and 8.0 mmhos/cm varied with stage of plant growth, time and salinity treatments. Root growth was greatest at soil depths of 20 to 60 cm in May, June, and July, a period of high growth rate and high evaporative conditions. During these months, average root intensities of sugarcane, irrigated with waters with salinities of 1.1, 5.0, and 8.0 mmhos/cm, were about 0.5, 1.0, and 1.5 mm/sq cm, respectively. Moisture stress induced by osmotic potentials of about -1.8 and -2.9 bar and high evaporative conditions stimulated root intensities but reduced top growth by 22 and 50%, respectively. These studies using root chambers have contributed to a better understanding of the interactive influences of stages of plant growth, salinity, and environment on root growth by sugarcane.

78:03C-003
THE EFFECT OF SALT PRECIPITATION AND HIGH SODIUM CONCENTRATIONS ON SOIL HYDRAULIC CONDUCTIVITY AND WATER RETENTION,
Frenkel, H., Hadas, A., and Jury, W.A.
California University, Riverside, Department of Soil and Environmental Sciences.
Water Resources Research, Vol. 14, No. 2, p 217-222, April, 1978. 5 fig, 4 tab,
21 ref, 8 equ.

Descriptors: Saline water, Water quality, Salinity, Irrigation, Leaching, Crop response, Pollution abatement, Chemical precipitation, Hydraulic conductivity, Soil-water-plant relationships.

Controlled irrigation management of moderate to poor quality water must assure sufficient movement of solution through the root zone to maintain a salinity regime which a crop can tolerate while at the same time minimizing the deterioration of groundwater or river quality. The work reported here analyzes the major plant-soil-salinity interactions resulting from irrigation with saline water at controlled leaching fractions. Simulations are run for leaching fractions of 0.30, 0.05, and 0.01 and three different water uptake patterns for two high-sulfate waters with different salinity levels: 2.1 and 6.6 mmho/cm. Results suggest that soil hydraulic conductivity and water retention should not be adversely affected by high sodium levels or cumulative salt precipitation even at very low leaching fractions. However, it is probable that plant activity will be impaired by the lower leaching fractions because of high osmotic pressure within the root zone and that root proliferation could be reduced by soil structure cementation resulting from salt precipitation.

78:03C-004
GRAPEFRUIT RESPONSE TO VARIABLE SALINITY IN IRRIGATION WATER AND SOIL,
Bielorai, H., Shalhevet, J., and Levy, Y.
Institute of Soils and Water, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel, Division of Environmental Physiology and Irrigation.
Irrigation Science, Vol. 1, No. 1, August, 1978, p 61-70. 3 fig, 4 tab, 16 ref.

Descriptors: Saline water, Irrigation water, Salinity, Crop response, Grapefruit, Osmotic pressure, Salts, Leaching, Saline soils.

Results were reported from a long-term field experiment designed to determine the effect of irrigation water salinity on the yield and water uptake of mature grapefruit trees. Treatments were started in 1970 and consisted of chloride concentrations in the irrigation water of 7.1, 11.4 and 17.1 meq/l added as NaCl + CaCl2 at a 1:1 weight ratio. For the last four years of the experiment, 1973 to 1976, yield was linearly related to the mean chloride concentration in the soil saturation extract weighted according to the distribution of water uptake with depth and time. There was a 1.45% yield reduction for each 1 meq/l increase in chloride concentration above a threshold value of 4.5 meq/l. This corresponded to a 13.5% decrease per 1 mmho/cm increase in the electrical conductivity of the soil saturation extract above a threshold value of 1.2 mmho/cm. Total water uptake was reduced as salt concentration in the soil increased. Salt accumulation in the soil depended on the quantity and salt concentration of the irrigation water, rainfall, and on the amount of leaching. No leaf symptoms of either Cl(-) or Na(+) injury were observed. The results indicate an osmotic--rather than a specific ion effect--of salinity on grapefruit yield.

78:03C-005
SALT TOLERANCE IN THE WILD RELATIVES OF THE CULTIVATED TOMATO: RESPONSES OF SOLANUM PENNELLII TO HIGH SALINITY,
Dehan, K., and Tal, M.
Ben Gurion University of the Negev, Beer Sheva, Israel, Department of Biology.
Irrigation Science, Vol. 1, No. 1, August, 1978, p 71-76. 5 tab, 12 ref.

Descriptors: Salt tolerance, Salinity, Tomatoes, Moisture deficit, Ions, Saline soils.

The cultivated tomato Lycopersicon esculentum, cultivar Rheinlands Ruhm, and the wild species Solanum pennellii accession Atico, were compared with respect to their salt tolerance. The wild species was found to be more salt tolerant than the cultivated tomato. In contrast to L. esculentum plants, the growth of the wild species was not impaired by the high salinity, although the latter accumulated more Cl(-) and Na(+) ions and its K+ level decreased under salinity. The smaller increase in water deficit under salinity in the wild species was attributed to its higher accumulation of ions.

78:03C-006
DRAINAGE PRACTICE IN IMPERIAL VALLEY,
Hermsmeier, L.F.
Imperial Valley Conservation Research Center, United States Department of Agriculture-Agricultural Research Service, Brawley, California.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 1, p 105-109, February 20, 1978. 1 fig, 7 tab, 10 ref.

Descriptors: Salinity, Drainage practices, Drainage, Drainage programs, Colorado River Basin, Saline water, Water quality, Salt balance, Colorado River, California.

The Imperial Valley in California has been irrigated by Colorado river water from the start of the century. The irrigation water quality was recognized as presenting possible drainage and salinity problems. As early as in 1902, irrigation engineers of the United States Department of Agriculture indicated that the water table and salinity of the valley needed to be controlled. Even to this day, the salinity remains to be a problem in the Imperial Valley. The purpose of this paper was to describe briefly all the drainage studies and developments that have taken place until the recent years. It also reports the soil types, climate, drainage cost and the crops grown in the valley.

SECTION XIV

WATER SUPPLY AUGMENTATION AND CONSERVATION

CONSERVATION IN DOMESTIC AND MUNICIPAL USE (GROUP 03D)

78:03D-001
ESTIMATION OF URBAN IRRIGATION WATER USE AND REQUIREMENT,
Fok, Y-S., and Murabayashi, E.T.
Hawaii University, Honolulu, Department of Civil Engineering.
Paper No. 78-2030, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 7 p. 7 ref, 1 equ.

Descriptors: Water conservation, Irrigation water, Landscaping, Consumptive use, Water requirements, Aesthetics, Water utilization, Vegetation, Estimating, Methodology.

The difference between normal urban irrigation water use and the consumptive use requirement is the potential amount of water that might be saved without adverse economic consequences to urban property values. These savings fit the general demand on better urban water use efficiency and/or urban water conservation. Methods for the estimation of urban irrigation water use and requirement are presented in this paper.

SECTION XV

WATER SUPPLY AUGMENTATION AND CONSERVATION

CONSERVATION IN AGRICULTURE (GROUP 03F)

78:03F-001
MANAGEMENT OF IRRIGATED SOYBEANS ON A MODERATELY COARSE-TEXTURED SOIL IN THE UPPER MIDWEST,
Cassel, D.K., Bauer, A., and Whited, D.A.
North Carolina State University, Charlotte, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 1, p 100-104, January-February, 1978. 2 fig, 4 tab, 22 ref.

Descriptors: Soybeans, Supplemental irrigation, Water management (applied), Fertilization, Nitrogen, Nitrates, Tensiometers, Leaching, Irrigation programs.

The objectives of this study were to determine the yield potential of supplementally irrigated soybeans on moderately coarse-textured soils and to develop an irrigation schedule for efficient water management. The study, conducted on Maddock sandy loam from 1972 to 1974, employed a split-split plot design with water level as the main block and N fertility rates (0, 56, 112, and 224 kg/ha) as subplots. Water levels were W1 (dryland), W2 (underirrigation), W3 (optimum) and W4 (overirrigation). Sub-subplots were planting dates in 1972 and cultivars in 1973 and 1974. Grain yields were significantly different for water levels during each of the three years. Three-year yield means were 543, 1,823, 2,428, and 2,164 kg/ha for W1, W2, W3, and W4, respectively. The application of 224 kg/ha N fertilizer in 1972 increased grain yield at the 0.95 probability level. An irrigation scheduling based upon tensiometers proved effective in applying irrigation water. Based upon results of this study, it was concluded that soybeans can be seriously considered as a crop to be included in cropping systems for irrigated, moderately coarse-textured soils in the Upper Midwest.

78:03F-002
EFFECTS OF CULTURAL PRACTICES ON GRAIN YIELD OF IRRIGATED WHEAT,
Day, A.D., Jackson, E.B., and Alemu, A.
Arizona University, Tucson, Department of Plant Sciences.
Agronomy Journal, Vol. 70, No. 2, p 279-282, March-April, 1978. 4 tab, 21 ref.

Descriptors: Wheat, Cultural control, Nitrogen, Fertilization, Crop production, Planting management, Beds, Irrigation.

Experiments were conducted at Yuma, Arizona, to study the effects of N fertilizer treatments in combination with methods of planting and row positions on beds, on the yield and quality of wheat grain. Six N fertilizer treatments (34, 17 + 17, 68, 34 + 34, 136, and 68 + 68 kg/ha), two methods of planting (on the flat and on beds), and four row positions on beds (north, south, east, and west) were evaluated. Flat plantings resulted in higher wheat grain yields than did bed plantings; however, bed plantings produced higher grain volume-weights. Within planting methods, N fertilizer treatments did not significantly influence grain yields or grain volume-weights. Grain yield components were similar for both planting methods. Wheat grown on beds with an east-west orientation produced more heads per unit area, more seeds per head, and higher grain yields than did wheat produced on beds oriented in a north-south direction. Wheat responded to N fertilization when grown on both flat and bed plantings during the winter months in the Southwest.

78:03F-003
EFFECT OF FERTILIZATION ON PENNCROSS CREEPING BENTGRASS,
Waddington, D.V., Turner, T.R., Duich, J.M., and Moberg, E.L.
Pennsylvania State University, University Park, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 5, p 713-718, September-October, 1978. 2 fig, 7 tab, 15 ref.

Descriptors: Fertilization, Turf grasses, Fertility, Productivity, Nitrogen, Phosphorus, Potassium, Soil tests.

A field study was conducted on fine, mixed soil to determine the effects of N sources (agrinite, Milorganite, ureaform, and urea), P rates (0, 0.49, 0.98, and 1.95 kg/100 m2), and K rates (0, 0.76, and 1.52 kg/100 m2) on soil nutrient levels and the growth, quality, and chemical composition of "Penncross" creeping bentgrass (Agrostis palustris Huds.) maintained as putting green turf. Wilting, disease, chlorosis, and annual bluegrass (Poa annua L.) infestation were used to assess quality. Fertilization with Milorganite increased available soil P and Mg. Application of K increased both tissue and available soil K. However, a greater increase in soil K and a smaller increase in tissue K were obtained by the second additional increment of K than the first one. The greatest change in tissue P occurred with the first incremental addition of P. Tissue P was not greatly affected by soil P above 224 ppm. Less severe summer wilting was observed with Agrinite, Milorganite, and K treatments. Annual bluegrass invasion was favored by P and K fertilization and the effect of one was enhanced by the other. Milorganite, which increased soil P, also favored annual bluegrass.

78:03F-004

EFFECTIVENESS OF NITRAPYRIN IN CONTROLLING NITRIFICATION OF FALL AND SPRING-APPLIED ANHYDROUS AMMONIA,

Hendrickson, L.L., Walsh, L.M., and Keeney, D.R.
Wisconsin University, Madison, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 5, p 704-708, September-October, 1978. 4 tab, 18 ref.

Descriptors: Nitrification, Inhibitors, Denitrification, Nitrogen, Ammonia, Crop response, Fertilizers, Corn (field).

Fertilizer N applied in the fall for the next growing season is often less efficient than N applied closer to the time of plant use. Efficiency might be greatly improved by maintaining the N as NH4, through the use of the nitrification inhibitor, Nitrapyrin [2-chloro-6 (trichloromethyl) pyridine]. To evaluate this hypothesis, field trials were established during 1975 to 1977 in south central Wisconsin using 84 to 168 kg/ha N applied as anhydrous ammonia with and without 0.55 kg/ha Nitrapyrin. The results indicated that while nitrification can be significantly slowed by application of nitrapyrin, a yield response does not result. It was thought that a response might have been obtained had a crop been grown on the poorly-drained area adjacent to the harvested area since appreciable N appeared to have been denitrified at this site. Nitrification inhibition by nitrapyrin varied widely within the same field. The results illustrated the problems involved in predicting whether nitrapyrin application will be effective in reducing nitrogen losses and increasing yields.

78:03F-005

EVALUATION OF NITRAPYRIN AS A MEANS OF IMPROVING N EFFICIENCY IN IRRIGATED SANDS,

Hendrickson, L.L., Keeney, D.R., Walsh, L.M., and Liegel, E.A.
Wisconsin University, Madison, Department of Soil Science.
Agronomy Journal, Vol. 70, No. 5, p 699-703, September-October, 1978. 3 fig, 5 tab, 24 ref.

Descriptors: Nitrification, Inhibitors, Nitrogen, Ammonia, Nitrates, Fertilizers, Potatoes, Leaching, Osmotic pressure.

The objective of this research was to determine if optimum levels of N might be maintained throughout the growing season by delaying nitrification with a nitrification inhibitor, Nitrapyrin. Several field experiments were conducted on a Plainfield loamy sand involving various N sources, rates, and times of application with and without Nitrapyrin. Potato tuber yield and the forms and distribution of N in and below the fertilizer bands were determined. Nitrapyrin extended the persistence of applied NH4 in all experiments, but inhibition of nitrification was of relatively short duration. Nitrapyrin persistence was likely reduced by the more rapid volatilization and hydrolysis in sandy soils. Further, the effectiveness of Nitrapyrin was likely limited by rapid leaching NH4 out of the Nitrapyrin-treated zone. Application of Nitrapyrin reduced both total tuber yield and the proportion of marketable tubers. The soil sampling data showed that Nitrapyrin maintained a much higher NH4-N/NO3-N ratio than comparable nonnitrapyrin treatments.

It appears that the predominance of NH4-N interfered with plant metabolism so that both yield and normal development of tubers were impaired.

78:03F-006
ZINC NUTRITION OF RICE AS INFLUENCED BY RATES OF GYPSUM AND ZN FERTILIZATION OF ALKALI SOILS,
Takkar, P.N., and Singh, T.
Punjab Agriculture University, Ludhiana, Department of Soils.
Agronomy Journal, Vol. 70, No. 3, p 447-450, May-June, 1978. 2 fig, 2 tab, 15 ref, 2 equ.

Descriptors: Rice, Nutrient requirements, Zinc, Gypsum, Alkaline soils, Crop response, Fertilization, Reclamation, Submerged plants.

Three field experiments were conducted on Zn deficient alkali soils, two on Natraquic calciorthids, and one on Aquic Camborthids, to determine the effect of gypsum and Zn fertilization alone and in combination on the Zn nutrition of rice IR 8. Three rates of gypsum and three rates of Zn and their possible combinations were tried. At all the three locations, the growth of the rice crop was very poor and exhibited Zn deficiency symptoms in control plots. The yield and Zn uptake was higher in alkali soil high in CaCO3 and low in pH than in soils low in CaCO3 and high in pH. Gypsum application markedly decreased the available Zn from deficient to adequate levels. Optimum response of rice to Zn was observed at 11.2 kg Zn/ha except in one of the Nitraquic calciorthids where it was 22.4 kg Zn/ha. The beneficial effect of Zn application to rice grown on the alkali soils under investigation was far more than that of gypsum.

78:03F-007
RADIATION AND ENERGY BALANCE OF SPRINKLER AND TRICKLE IRRIGATED FIELDS,
Ben-Asher, J., Fuchs, M., and Goldberg, D.
Ben-Gurion University, Beer Sheva, Israel, Institute of Soil and Water.
Agronomy Journal, Vol. 70, No. 3, p 415-417, May-June, 1978. 1 fig, 2 tab, 13 ref, 8 equ.

Descriptors: Water conservation, Sprinkler irrigation, Tomato, Evaporation, Energy budget, Evapotranspiration, Radiation, Albedo.

Water conservation claims in favor of trickle irrigation are poorly documented. The radiation and energy balance of tomatoes grown on sand dune soil and on bare soil irrigated by sprinkling and trickling were compared. Under trickle irrigation, the average ratio of five energy balance measurements of evapotranspiration over evaporation pan (Class A) was 0.3, compared with 0.60 obtained under sprinkler irrigation. The comparison of radiation balance over the trickle and sprinkler irrigated plots indicates that the increased radiant heat loss and albedo from the dry portion of the trickle irrigated plot decreases the available evaporative energy at ground level. The smaller radiant heat load combines with the resistance of the dry soil to water flux to reduce the evaporation of the trickle irrigated plot.

78:03F-008
INFLUENCE OF WATER AND FERTILIZER MANAGEMENT ON YIELD AND WATER-INPUT EFFICIENCY OF CORN,
Rhoads, F.M., Mansell, R.S., and Hammond, L.C.
Florida University, Quincy, Department of Soil Sciences.
Agronomy Journal, Vol. 70, No. 2, p 305-308, March-April, 1978. 2 fig, 4 tab, 9 ref.

Descriptors: Corn (field), Water management (applied), Fertilizers, Nutrients, Irrigation, Leaching, Soil-water-plant relationships.

This study was conducted to evaluate efficiency of water input in terms of corn grain yield per unit of water, with two fertilizer application methods under three soil-water management systems on a Troup loamy sand. Water management consisted of (a) control--natural rainfall only, (b) trickle irrigation scheduled daily (0.64 cm/day), and (c) trickle irrigation scheduled by tensiometer (1.30 cm/application). Tensiometers were placed in each treatment at six depths between 15 and 150 cm below the soil surface and readings were recorded daily. Methods of applying fertilizers were designated (a) conventional--1/3 of N and all P and K applied broadcast preplant, and remainder of N applied in two sidedressings; (b) program fertilization--N-P-K applied broadcast in small increments (5, 5, 10, 20, 20, 20, and 20%) at two-week intervals after corn emerged. Average grain yields for the above water management treatments were 2,790, 4,160, and 5,700 kg/ha respectively. Highest irrigation water-input efficiency (150 kg/ha/cm) occurred with program fertilization and tensiometer scheduled irrigation. Irrigation water-input efficiency was lowest (10 kg/ha/cm) with corn receiving daily irrigation and conventional fertilization.

78:03F-009
ECONOMIC ANALYSIS OF IRRIGATION PRODUCTION FUNCTIONS: AN APPLICATION OF LINEAR PROGRAMMING,
Pomareda, C.
International Bank for Reconstruction and Development, Washington, D.C., Development Research Center.
Water Resources Bulletin, Vol. 14, No. 1, p 24-34, February, 1978. 1 fig, 4 tab, 9 ref.

Descriptors: *Economic analysis, *Irrigated agriculture, *Linear programming, *Water utilization, *Production function, Optimization, Resource allocation, Profit, Crops, Mathematical models.

For estimating the yield response to irrigation water, good and varied information is available; however, little and only partial (for individual crops) economic analysis has been made of this information. Herein, the economic analysis of irrigation production functions is discussed and a modified separable linear programming model is used for examining optimal levels of water use when, at the farm level, various crops with different water response functions compete for the same scarce resource. The effects of alternative water availabilities on the optimal levels of water use are explored using a multicrop farm model in which, in principle, the full water response function for each crop can be included. The farm objective function is specified as the maximization of profits from various crops, given a restriction in the availability of water and other inputs. This method provides advantage over the partial one-crop type of analyses because it captures intercrop tradeoffs in water and land use in response to economic policies or changes in water supply.

78:03F-010
NITROGEN BALANCES FOR THE SANTA MARIA VALLEY,
Lund, L.J., Ryden, J.C., Miller, R.J., Laag, A.E., and Bendixen, W.E.
California University, Riverside, Department of Soil and Environmental Sciences.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 395-413, May 15-18, 1978. 6 tab, 7 ref.

Descriptors: Nitrogen, Nutrient removal, Denitrification, Vegetable crops, Leaching.

A simplified steady-state model has been used to develop nitrogen balances in the Santa Maria Valley, California. Balances have been developed for selected management units and for the valley as a whole. The balance developed for a field cropped with vegetables for the past twelve years showed that 30% of the applied nitrogen was removed in harvested crop, 37% was leached below the root zone and 33% was unaccounted-for, which was attributed to gaseous losses of nitrogen as products of denitrification. Direct field measurement of denitrification over an eight-month period at one site in the same field found a 29% loss of the applied nitrogen. The first estimation of the nitrogen balance in the valley attributed 24% of the applied nitrogen to removal in harvested crops, 39% to leaching and 37% to denitrification.

78:03F-011
ECONOMIC CONCEPTS AND POLICIES RELATED TO CONTROLLING NONPOINT SOURCE POLLUTION STEMMING FROM AGRICULTURE,
Whittlesey, N.K., and Barkely, P.W.
Washington State University, Pullman, Department of Agricultural Economics.
Proceedings of National Conference on Management of Nitrogen in Irrigated

Agriculture, California University, Sacramento, California, p 333-353, May 15-18, 1978. 14 ref.

Descriptor: Pollution abatement.

This paper describes the role of economics in solving nonpoint source pollution problems in terms that are understandable for the noneconomist. An economist attempts to watch over the process of converting natural resources into marketable commodities to assure that the process achieves the greatest possible good for members of society. Economic tools are well equipped to handle this process for goods and resources known as private property, those items used exclusively by the individual owners. Unfortunately, most pollution problems occur through the use and misuse of public property, those items owned and used jointly by all members of society. Air and water are the most common examples of public property. The paper describes economic concepts and public policies that are useful for internalizing the costs caused by pollution and abating or solving pollution caused problems. The concepts of opportunity cost and income distribution and their role in pollution abatement are discussed. Methods of choosing levels of abatement include the extremes of zero pollution and that which can be achieved by best management practices. The economic and social optimum probably lies between these extremes. Arbitrary standards are sometimes imposed as a compromise between the extremes of zero pollution and no abatement in an effort to approximate optimal levels of abatement.

78:03F-012
DIAGNOSTIC TECHNIQUES USED TO IDENTIFY OPTIMUM LEVELS OF NITROGEN FERTILIZATION FOR IRRIGATED CROPS,
Jackson, T.L.
Oregon State University, Corvallis, Department of Soil Science.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 321-332, May 15-18, 1978. 27 ref.

Descriptors: Nitrogen, Fertilization, Irrigation water, Nitrates.

The nitrogen available for plant growth comes primarily from 1) the nitrogen released from soil humus and crop residues, 2) nitrogen added as commercial fertilizers and 3) residual inorganic nitrogen from previous growing seasons or previous crops. Irrigation ensures adequate moisture and relatively uniform yields from year to year. Irrigation also makes feasible the application of fertilizer nitrogen during the growth of the crop and this provides the opportunity to use soil and plant analysis early in the crop season to assess nitrogen needs. Examples of the use of diagnostic techniques for estimating the fertilizer nitrogen required to supplement residual nitrogen levels and the capacity of the soil to release nitrogen are presented.

78:03F-013
USE OF MATHEMATICAL RELATIONSHIPS TO DESCRIBE THE BEHAVIOR OF NITROGEN IN THE CROP ROOT ZONE,
Davidson, J.M., and Rao, P.S.C.
Florida University, Gainesville, Department of Soil Science.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 291-319, May 15-18, 1978. 7 fig, 3 tab, 27 ref, 7 equ.

Descriptors: Nitrogen, Denitrification, Root zone, Soil water movement, Mathematical studies.

A procedure to estimate the movement of water-soluble nitrogen species (NO3 and NH4) was developed by assuming that (i) the soil-water residing in all pore-sequences participates in the transport process, and that (ii) the soil-water initially present in the soil profile was completely displaced ahead of the water entering at the soil surface. Field-capacity and initial soil-water content distribution in addition to total water inputs were necessary parameters to estimate solute transport in the root zone. First-order kinetics were assumed to describe the nitrogen transformations (mineralization, immobilization, nitrification, and denitrification). These transformation processes were considered to occur under ideal conditions. Plant uptake of water and nitrogen (nitrate and ammonium) was estimated, respectively, from potential evapotranspiration and nitrogen uptake rate under ideal environmental conditions for a given crop. Actual plant uptake of water and nitrogen was dependent upon the available soil water and total mineral nitrogen within the crop root zone. These mathematical relationships could be solved using a programmable desk-top calculator; however, a larger computer was needed when more complex submodels were employed to describe soil-water uptake. The proposed mathematical relationships can provide field managers and regulatory personnel with an integrated description of the behavior of nitrogen in the root zone during a crop growing season.

78:03F-014
MONITORING WATER FOR NITROGEN LOSSES FROM CROPLANDS,
Tanji, K.K.
California University, Davis, Department of Land, Air and Water Resources.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 251-263, May 15-18, 1978. 10 ref.

Descriptors: Nitrogen, Return flow, Irrigated lands, Monitoring, Water quality.

This paper reviews monitoring for nitrogen in surface and subsurface return flows from irrigated lands. Presented are the elements of a monitoring program: objectives of monitoring, parameters to be measured, sampling programs that include site selection, sampling frequency and sampling method, laboratory methods for nitrogen determinations, requirements for resources and facilities, evaluations of collected data and other support information and data, and dissemination of monitored results. Each of these elements are appraised and a conclusion is drawn on monitoring waters for nitrogen losses from croplands.

78:03F-015
EFFECT OF WATER MANAGEMENT ON NITRATE LEACHING,
Letey, J., Biggar, J.W., Stolzy, L.H., and Ayers, R.S.
California University, Riverside, Department of Soil and Environmental Sciences.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 231-249, May 15-18, 1978. 4 fig, 3 tab.

Descriptors: Nitrates, Leaching, Water pollution, Water management, Nitrogen, Fertilization, Effluents, Correlation analysis.

Nitrates which are leached (transported below the root zone) represent a resource loss and a potential contribution to water pollution. The amounts of leached nitrates for a given time period were determined at various commercial farming sites in California and in a carefully controlled experimental plot receiving various water and fertilizer application treatments. Some of the agricultural sites had tile drainage systems and others had "free drainage" to the groundwater. Linear regression analyses were conducted on the data. Similar results were observed for the tile and free drainage systems. The highest correlation coefficient was for amount leached versus drainage volume followed by amount leached versus fertilizer nitrogen application. In most cases there was no significant correlation between nitrate concentration in the water below the root zone and drainage volume or fertilizer nitrogen application. A significant linear relationship between amount of leached nitrate and drainage volume was also obtained at the experimental plot.

78:03F-016
LEACHING OF NITRATE FROM SOILS,
McNeal, B.L., and Pratt, P.F.
Washington State University, Pullman, Department of Agronomy and Soils.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 195-230, May 15-18, 1978. 4 fig, 5 tab, 35 ref.

Descriptors: Nitrates, Nitrogen, Leaching, Irrigated land, Denitrification, Waste disposal.

Calculation of soil solution nitrate concentrations, and of mass emissions of nitrate, are illustrated. Estimation of average water flux from nitrate/chloride ratios, and from drain field outflows, are discussed. The high potential for nitrate leaching from irrigated animal and municipal waste disposal sites is mentioned, with stress being placed on the high denitrification potential at many such sites, because of high soluble carbon loadings, high soil microbe levels, and rapid oxygen depletion. Root zone and subsoil nitrate-nitrogen values are provided for typical croplands of southern California and central Washington. Such values are related to irrigation management and to downward water flux. Crop differences in ability to utilize all soluble nitrate from the soil solution are stressed, and some management alternatives for preventing deep percolation losses of nitrate are detailed. Predictions of nitrate leaching losses from data for nitrogen application rate and drainage water volume are discussed. Typical predictions are presented and are compared to experimentally-measured values. Overprediction of nitrate leaching estimates for some furrow-irrigated tracts in the Pacific Northwest is demonstrated.

78:03F-017
VOLATILE LOSSES OF NITROGEN FROM SOIL,
Rolston, D.E.
California University, Davis, Department of Land, Air and Water Resources.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 169-193, May 15-18, 1978. 4 fig, 18 ref.

Descriptors: Denitrification, Volatility, Nitrogen, Fertilization.

Nitrogen may be lost from soil in the gaseous form by two major mechanisms, ammonia volatilization and denitrification. Ammonia gas may be lost to the atmosphere whenever ammonium compounds are applied to the soil surface. The greatest ammonia losses occur from calcareous soils at high soil pH. Fertilizers such as urea and ammonium sulfate result in greater ammonia loss than that from ammonium nitrate when applied to a moist soil surface. More than 50% of the applied fertilizer may be lost by ammonia volatilization if precautions are not taken. The best solution for minimizing ammonia loss is to incorporate or place ammonium compounds approximately 10 cm below relatively dry surface soil. The volatile products of denitrification, nitrous oxide and nitrogen gas, may be lost from the soil whenever the soil becomes wet enough that oxygen becomes depleted and sufficient carbon is available from organic materials to support microbial activity. Denitrification occurs significantly only over a very narrow soil-water content range near saturation and in those portions of the soil profile with fairly high organic material. Consequently, denitrification will generally only occur in the surface 60 cm of most soils of arid regions unless perched water tables exist at a buried surface horizon. Management practices to either minimize or maximize denitrification should be directed at controlling nitrate position and water content in the surface soil.

78:03F-018
REMOVAL OF NITROGEN BY VARIOUS IRRIGATED CROPS,
Tucker, T.C., and Hauck, R.D.
Arizona University, Tucson, Department of Soils, Water and Engineering.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 135-167, May 15-18, 1978. 2 fig, 7 tab, 16 ref.

Descriptors: Nitrogen, Nutrient removal, Crop production, Fertilizers, Soil management.

Harvested agronomic and horticultural plants, excluding rice, are grown under irrigation on over 16 million hectares of land in 33 states. Results of a survey of published and recent unpublished information on removal of soil and fertilizer nitrogen from irrigated land in the harvested portion of crops was presented. The amount of nitrogen removed varied considerably among different plant species and within the same species when grown under widely different management and environmental conditions. The amount of fertilizer nitrogen apparently removed by grain crops generally was within the average range for all crops, 40 to 60% of the nitrogen applied. Fertilizer efficiency is discussed from three main viewpoints: in terms of (1) the amount of applied nitrogen found in the plant, (2) the yield of harvested plant parts in relation to amount of fertilizer nitrogen applied, and (3) the cash value of marketable crop in relation to nitrogen cost. Examples are given, using data for coastal bermudagrass and wheat, of fertilizer efficiency as calculated on the basis of these viewpoints. Methodological problems of collecting data and problems of data interpretation are discussed in relation to the several concepts of fertilizer efficiency, and emphasis is placed on the need to recognize the role of all soil, fertilizer, and crop management factors in determining the efficiency by which plants use nitrogen.

78:03F-019
THE INDISPENSABLE ROLE OF NITROGEN IN AGRICULTURAL PRODUCTION,
Olson, R.A.
Nebraska University, Lincoln, Department of Agronomy.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 1-31, May 15-18, 1978. 10 fig, 2 tab, 35 ref.

Descriptors: Nitrogen, Fertilizers, Nutrients, Crop production, Crop response, Pollutants.

The indispensable role of nitrogen in food and fiber production for the world's people cannot be disputed. There is no substitute for nitrogen in its essential roles as a component of the chlorophyll and protein constituents of crop plants. The quantity required for obtaining an economic yield of most crops exceeds that of all other soil-derived essential nutrients. The advent of relatively cheap fertilizer nitrogen in the 1950's caused radical increases in yields obtainable with most crops in the developed countries and provided the spark that ignited the Green Revolution in many of the Less Developed Countries in the 1960's as well. Its preeminence in the food production chain notwithstanding, nitrogen has been subjected recently to more critical surveillance than any other element in agriculture by reason of energy expended in its conversion into fertilizers, its monetary cost to the farmer, and its potential role as environmental pollutant. The economic and environmental problems can be minimized, however, by matching rate and timing of applied nitrogen with the amount likely to be provided the soil during the growing season and with the water regime afforded. The agricultural sector must achieve this matching objective promptly if it is not to be condemned by the rest of society in the long term.

78:03F-020
ASSESSING THE SPATIAL VARIABILITY OF IRRIGATION WATER APPLICATIONS,
Karmeli, D., Salazar, L.J., and Walker, W.R.
Colorado State University, Fort Collins, Colorado, Department of Agricultural and Chemical Engineering.
Publication No. EPA-600/2-78-041, March, 1978. 201 p, 38 fig, 25 tab, 71 ref, 6 append.

Descriptors: Irrigation, Efficiency, Sprinkler irrigation.

The current state of the art regarding the spatial distributions of irrigation water applications under surface, sprinkler, and trickle irrigation systems has been assessed. The analyses found in the literature and several new uniformity concepts have been integrated into models which can be used in both field and research applications. These models stimulate the spatial distributions of applied irrigation water under specified design and operating conditions. The performance of an irrigation system has been described by a series of "quality" parameters relating to: (1) uniformity in an irrigated field; (2) adequacy of the irrigation system in meeting crop requirements; (3) volume of applied water wasted as deep percolation; and (4) in the case of surface irrigation, the water leaving the field as tailwater. Verification of the models developed during this project was made against most of the data identified in the literature as well as an intensive collection effort as part of this project. The results illustrate both the use of the analytical approach and the procedures for field data collection.

78:03F-021
RELATIVE EVALUATION OF WATER STRESS INDICATORS FOR SOYBEANS,
Sivakumar, M.V.K., and Shaw, R.H.
International Crops Research Institute for Semi-Arid Tropics, Hyderabad 500 016, India.
Agronomy Journal, Vol. 70, No. 4, p 619-623, July-August, 1978. 7 fig, 1 tab, 23 ref, 1 equ.

Descriptors: Soybeans, Soil-water-plant relationships, Moisture stress, Moisture deficit, Growth rates, Plant growth, Soil water, Iowa, Indicators.

Field studies were conducted during 1976 on Ida silt loam (fine, silty, mixed (calcareous) mesic family of Typic Udorthents) at the Western Iowa Experimental Farm, Castana, Iowa, to evaluate three plant measurements (vis., stomatal conductance, leaf-water potential, and leaf area) as water stress indicators for soybeans (Glycine max (L.) Merr.). Daily means of stomatal conductance and leaf-water potential measured several times during the growing season were closely related to changes in soil-water potential. "Rate of leaf-area expansion" which is defined as the change in average leaf area (leaf area/number of leaves) per plant over a period of time, also showed a close correspondence with soil-water potential. Relative growth rates of soybeans showed a negative correlation with stomatal conductance, leaf-water potential, and rate of leaf-area expansion. The three plant measurements should prove useful in explaining water-deficit effects quantitatively under field conditions.

78:03F-022
ACCUMULATION AND REDISTRIBUTION PATTERN OF DRY MATTER AND N IN TRITICALE AND WHEAT VARIETIES UNDER WATER STRESS CONDITION,
Lal, P., Reddy, G.G., and Modi, M.S.
California University, Davis, Department of Land, Air and Water Resources.
Agronomy Journal, Vol. 70, No. 4, p 623-626, July-August, 1978. 1 fig, 3 tab, 16 ref.

Descriptors: Cereal crops, Wheat, Moisture stress, Varieties, Nitrogen, Economic efficiency, Translocation, Moisture deficit, Crop production, Grains (crops).

The objective of this study was to screen varieties of triticale (Triticale hexaploide Lar.) relative to wheat (Triticum aestivum L.) for their high translocation ability and N utilization efficiency. A field experiment was conducted on silt loam soil (Typic Hapludoll) during 1973-74 at Pantnagar, India. Treatments consisting of five varieties each of triticale and wheat were arranged in a randomized block design with five replications. Plant samples were collected from a 0.125-sq m area for dry matter and N content studies in culm, lower leaf, flag leaf, spike chaff, and grain at successive stages. The loss of dry matter from different plant parts was assumed to be translocated to the grains. Both triticale and wheat cultivars differed greatly in their capacity to accumulate and redistribute dry matter and N. On an average, triticale cultivars removed larger amounts of N than the wheat.

78:03F-023
INFLUENCE ON MANURE APPLICATION RATES AND CONTINUOUS CORN ON SOIL-N,
Magdoff, F.R.
Vermont University, Burlington, Department of Plant and Soil Science.
Agronomy Journal, Vol. 70, No. 4, p 629-632, July-August, 1978. 2 tab, 18 ref, 6 equ.

Descriptors: Corn(field), Decomposing organic matter, Organic matter, Nitrogen, Crop response, Nutrient requirements, Rates of application, Sites.

The manure-N experiments with continuous corn (Zea mays L.) were conducted on both a somewhat poorly drained Panton clay (Typic Ochraqualf) and a well-drained Calais loam (Typic Fragiorthod). Manure rates of 0, 22, 44, and 66 metric tons/ha/year were combined in factorial arrangement with ammonium nitrate rates of 0, 112, and 224 kg N/ha/year. Comparison of calculated theoretical soil-N with experimentally determined levels after five years and the response of corn to fertilizer-N indicate that mineralization of manure organic-N, when applied to the Panton clay, was less than when applied to the Calais loam. Thus, manure-N was less available to the growing crop on the clay and accumulated in the soil at a greater rate than in the loam. The annual manure application rates required to maintain initial soil N levels in Panton clay and Calais loam under continuous corn production were calculated to be 40 to 52 tons/ha respectively. Two mineralization models were examined: Model 1 assumed only the first year manure mineralization rate above native soil organic matter decomposition rate; Model 2 assumed a five-year mineralization decay series. Both were effective in predicting final soil-N levels.

78:03F-024
INFLUENCE OF FERTILIZER AND RESIDUE MANAGEMENT ON GRASS SEED PRODUCTION,
Canode, C.L., and Law, A.G.
Washington State University, Pullman, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 4, p 543-546, July-August, 1978. 3 tab, 8 ref.

Descriptors: Grasses, Wheatgrass, Fescues, Bromegrass, Fertilization, Burning, Air pollution.

The experiments were conducted on a silt loam soil (Pachi Ultic Haploxerolls) as a split-plot within each grass species. Main plots were three levels of 18-10-10-7 fertilizer applied to supply N at 90, 112, and 135 kg/ha, with an associated increase in P, K, and S. Main plots were split for open burning and two levels of mechanical residue removal. Two crops of red fescue and four seed crops of smooth bromegrass and crested wheatgrass were evaluated. Average seed yields (kg/ha) for burning compared with mechanical straw removal were 636 vs. 495 for red fescue, 1,122 vs. 848 for smooth bromegrass, and 872 vs. 790 for crested wheatgrass. Interactions of fertilizer rates and residue management were not significant. The increase in seed production resulting from burning residue apparently was associated with control of downy bromegrass (Bromus tectorum L.) and increased vigor of autumn growth.

78:03F-025
RESPONSE OF CORN TO ZN IN ORTHO- AND PYROPHOSPHATE FERTILIZERS, AS AFFECTED BY SOIL TEMPERATURE AND MOISTURE,
Giordano, P.M., and Mortvedt, J.J.
National Fertilizer Development Center, Tennessee Valley Authority, Muscle Shoals, Alabama, Soil and Fertilizer Research Branch.
Agronomy Journal, Vol. 70, No. 4, p 531-534, July-August, 1978. 2 fig, 2 tab, 8 ref.

Descriptors: Fertilizers, Phosphates, Sweet corn, Zinc, Phosphorus, Soil moisture, Soil temperature, Crop response, Plant growth.

The purpose of this investigation was to determine the effects of both soil temperature and moisture regimes on the uptake of Zn and P by corn (Zea mays L.) from ZnSO4, granulated with ammonium ortho- and polyphosphate fertilizers and applied to Nolichucky scl (pH 7.6), a Typic Paleudult soil. In a series of greenhouse experiments, corn grown under various soil temperature (16 to 32 C) and moisture regimes (0.3 to 0.15 atm) showed a marked reduction in dry matter yield, as well as in Zn and P uptake, at low temperature, but varying soil moisture levels had little effect. Uptake of Zn was greater when triammonium pyrophosphate rather than monoammonium phosphate was the source of applied P, but uptake of P from the two P sources was comparable. Although lower Zn uptake appears to be a function of depressed growth under cool soil conditions, it is likely that deficiency arises because early Zn requirements cannot be met when the available Zn supply is low. Uptake and yield results further suggest that early growth retardation sometimes attributed to Zn deficiency during cool springs also may be related to suppression of P uptake.

78:03F-026
RADIATION AND ENERGY BALANCE ON A TRICKLE-IRRIGATED LEMON GROVE,
Ben-Asher, J., and Sammis, T.W.
Arizona University, Tucson, Water Resources Research Institute.
Agronomy Journal, Vol. 70, No. 4, p 568-572, July-August, 1978. 4 fig, 2 tab, 7 ref, 7 equ.

Descriptors: Water conservation, Irrigation, Irrigation systems, Energy budget, Evapotranspiration, Lemons, Albedo, Radiation.

This study was conducted to evaluate the water saving potential and evapotranspiration from a trickle irrigated lemon grove (Citrus limon L. "Lisbon"). Detailed measurements of global, reflected, and net radiation and its dissipation above the plant, the unshaded sandy soil, and the area as a whole were made in the spring and summer of 1975. Two sources of radiant energy were observed: net radiation which accounted for 70% of the energy utilized in evapotranspiration and reflected radiation from the unshaded soil accounting for 30%. Experimentally the net radiation and evapotranspiration of the wet complex increased as the average net radiation and the evapotranspiration from the area as a whole decreased and vice versa. On the other hand, evapotranspiration and its ratio to evaporation from a class A pan were smaller than any previously reported values. Therefore, it is suggested that for these two periods the contribution of energy from the dry area to the wet did not reflect a specific disadvantage for trickle irrigation.

78:03F-027
YIELDS, NUTRIENT REMOVAL, AND NUTRIENT CONCENTRATIONS OF DOUBLE-CROPPED CORN AND SMALL GRAIN SILAGE,
Murdock, L.W., and Wells, K.L.
Kentucky University, Lexington, Department of Agronomy.
Agronomy Journal, Vol. 70, No. 4, p 573-576, July-August, 1978. 7 tab, 7 ref.

Descriptors: Sweet corn, Barley, Oats, Silage, Crop response, Crop production, Nutrient removal, Kentucky.

The study was initiated to determine production levels from double-cropped silage, the most compatible small grain species for double-cropped silage, and the rate and method of fertilizer application needed for high production. Field experiments were established on Huntington (fine-silty, mixed mesic fluventic Hapludoll) and Pope (coarse-loamy, mixed, mesic fluventic Dystrochrept) soils. Three fertility levels were tested with 392-128-280, 280-89-232, or 168-54-140 kg/ha of N-P-K being applied each year. Single and split applications of K were studied. Barley (Hordeum vulgare L.) and oats (Avena sativa L.) were compared as small grain species. This study indicates that double-cropped corn and small grain for silage can result in substantially higher dry matter production per unit land area than single-cropped corn. Large amounts of minerals are removed, however, particularly K, by the small grain component of the double-cropping system.

78:03F-028
SUGAR BEET GENOTYPE, N, AND SOIL MOISTURE AVAILABILITY INTERACTIONS IN COMPONENTS OF BEET YIELD AND QUALITY,
James, D.W., Doney, D.L., Theurer, J.C., and Hurst, R.L.
Utah State University, Logan, Department of Applied Statistics and Computer Science.
Agronomy Journal, Vol. 70, No. 4, p 525-531, July-August, 1978. 8 fig, 2 tab, 16 ref.

Descriptors: Sugar beets, Nitrogen, Soil moisture, Crop response, Crop production, Varieties.

This study was conducted to investigate the genotype of sugar beet (Beta vulgaris L.) X soil N and genotype X soil water interaction from a broad genetic base. A series of 20 genetically different genotypes differing in yield, sugar percent, and impurity index potential were field tested in 1974 at four N levels: 0, 84, 210, and 525 kg/ha. In 1975, eight genetically diverse genotypes were field tested at five N levels and four irrigation levels. The soil type was coarse, loamy mixed mesic family of calcic haploxerolls. Analysis of data were for root yield, sucrose percent, gross sugar, and impurity index. Highly significant main effects due to N in 1974 and 1975 and water in 1975 were observed for all measured parameters. A significant genotype (V) X (N) interaction was obtained in 1974 for all parameters. There was an apparent genotype X water interaction in 1975; however, unbiased statistical inferences could not be made because of the experimental design. These interactions indicate that genetic variation exists such that new cultivars may be developed that give high sugar production at low N levels or are not affected adversely in quality at a high N level.

78:03F-029
INHIBITION OF UREASE ACTIVITY BY HETEROCYCLIC SULFUR COMPOUNDS,
Gould, W.D., Cook, F.D., and Bulat, J.A.
Alberta University, T6G 2E1, Edmonton, Alberta, Canada, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 1, p 66-71, January-February, 1978. 3 fig, 5 tab, 30 ref.

Descriptors: Urea, Nitrogen, Nitrification, Inhibitors, Sulfur compounds, Soil investigations, Volatility, Hydrolysis.

The inhibition of both jack bean urease and soil urease by several heterocyclic mercaptans was investigated. The following compounds not previously tested as urease inhibitors were found to be effective inhibitors of jack bean urease: 1,3,4-thiadiazole-2,5-dithiol; 5-mercapto-3-phenyl-1,3,4-thiadiazole-2-thione; and 5-amino-1,3,4-thiadiazole-2-thiol. The disulfides of the latter two compounds were found to be very potent inhibitors of jack bean urease. The results are consistent with an inhibition mechanism involving a thiol-disulfide exchange reaction between a disulfide and one or more of the sulfhydryl groups of urease. The results also imply that inhibition of urease by the heterocyclic mercaptans was due to trace amounts of the corresponding disulfides or polysulfides in the mercaptan preparations. A number of heterocyclic mercaptans, two disulfides, and a number of known urease inhibitors were evaluated as soil urease inhibitors, and the following compounds were the most effective: 1,4-benzoquinone; hydroquinone > 2,5-dimethyl-1,4-benzoquinone; catechol; 1,3,4-thiadiazole-2,5-dithiol; 2,6-dimethyl-1,4-benzoquinone.

78:03F-030
NONUNIFORM SPRINKLER IRRIGATION APPLICATION EFFICIENCY,
Chaudhry, F.H.
de Sao Paulo Universidade, Sao Carlos, Brazil, Department of Hydraulics and Sanitary Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR2, p 165-178, June, 1978. 4 fig, 15 ref, 43 equ, 3 append.

Descriptors: Irrigation efficiency, Sprinkler irrigation, Uniformity coefficient, Distribution, Statistical methods, Irrigation, Irrigation design.

Application efficiency offers a physically significant characterization of nonuniform irrigation which can help in striking a balance between the cost of maintaining higher uniformity and the cost of water. This paper quantifies the role of asymmetry in the various efficiency parameters of nonuniform irrigation representing its areal pattern by a skew distribution. It is shown that if the application ratio or the coefficient of variation, or both, are small, the application efficiency approaches the value of the application ratio. The equality between the application ratio and the application efficiency can be obtained at relatively larger coefficients of variation (or smaller uniformity coefficients) for positively skewed distributions. Given the statistical properties of the sprinkler or surface irrigation distribution and the proposed application ratio, the results of this study should permit a more accurate evaluation of the application efficiency and thus of the economics of the proposed installations.

78:03F-031
EFFECT OF IRRIGATION REGIME ON MAIZE YIELDS,
Barrett, J.W.H., and Skogerboe, G.V.
Colorado State University, Fort Collins, Department of Agriculture and Chemical Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR2, p 179-194, June, 1978. 9 fig, 2 tab, 20 ref, 1 append.

Descriptors: Yield equations, Sweet corn, Crop response, Moisture stress, Water requirements, Growth stages, Evapotranspiration, Crop production, Irrigation, Irrigation efficiency.

To determine the economically optimal allocation of irrigation water to a given crop, the relationship between the yield of the crop and its use of the supplied water must be known. Different shapes of the function relating yield to water use have been obtained by various researchers. The strongly linear relationship between wheat grain yield and precipitation has been supported by container and field experiments that have demonstrated for many crops a linear relationship between yield and water use until maximum yield is obtained. The purpose of this paper is to present field evidence substantiating the form of the crop yield-water use function and to demonstrate the effects of different irrigation regimes on the yield of corn.

78:03F-032
WATER TREATMENTS IN TRICKLE IRRIGATION SYSTEMS,
Nakayama, F.S., Gilbert, R.G., and Bucks, D.A.
Agricultural Research Service, Phoenix, Arizona, Department of Agriculture.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, p 23-34, March, 1978. 11 fig, 1 tab, 12 ref, 1 append.

Descriptors: Irrigation water, Water treatment, Irrigation systems, Clogging, Orifices, Water quality, Water analysis, Water pollution control, Filtration, Colorado River.

A comprehensive two-year study on trickle irrigation systems using Colorado River water in southwestern Arizona has shown that adequate water filtration is a primary requirement for reliable emitter operation. Filtration systems must be able to handle local peak loads in suspended particulates from the source water. For the long-term operation of the trickle system, the practice of flushing mains, submains and lateral lines, and chemical water treatment is essential for controlling the buildup of sediment, precipitates, and microbial slime. Precautions must be taken to ensure that the emitters, line materials, and other equipment are resistant to chemicals such as fertilizer, bactericide, insecticide, and herbicide that may be injected into the system.

78:03F-033
BASIC IRRIGATION SCHEDULING PROCEDURES,
Fischbach, P.E.
Nebraska University, Lincoln, Department of Agricultural Engineering.
Irrigation Age, Vol. 12, No. 7, p 66-67, April, 1978. 2 fig.

Descriptors: Irrigation, Irrigation water, Scheduling, Soil moisture, Moisture content, Growth stages, Sweet corn, Moisture meters, Evapotranspiration, Water conservation.

On a fine textured deep soil, four basic irrigation scheduling procedures were compared on corn. The procedures consisted of irrigations according to (1) the calculated crop water use, (2) the average electrical resistance block reaching, (3) the soil moisture content (feel method) at three stages of growth of the corn plant, and (4) a predetermined range of net water application every fourteen days. The difference between grain corn yields were not significant at the 5% level between scheduling procedures. The least effort to schedule irrigations was with the electrical resistance blocks. Applying only 2 inches of net irrigation water or less each irrigation is important so that nitrogen, water or energy is not wasted. Using a water measuring meter to know how much water was applied appears to be the most critical measurement to save nitrogen, water and energy.

78:03F-034
ON-FARM LEVEL-BASIN IRRIGATION--SAVE WATER AND ENERGY,
Dedrick, A.R., Replogle, J.A., and Erie, L.J.
Agricultural Research Service, Phoenix, Arizona, U.S. Department of Agriculture.
Civil Engineering, Vol. 48, No. 1, p 60-65, January, 1978. 8 fig.

Descriptors: Surface irrigation, Basins, Irrigation efficiency, Irrigation systems, Irrigation practices, Water distribution (applied), Energy loss, Water conservation, Automation.

Spiraling energy costs, and the doubtful availability of electricity or natural gas for pumping, stand as a serious threat to future high-energy-consuming water application techniques. Even with the growing concern for water conservation, we may run out of energy before we run out of water. Surface irrigation, because of its lower energy requirements, deserve renewed attention. Thus, despite the merits of sprinkler and trickle irrigation, conversion from surface irrigation should be approached cautiously, especially where properly designed surface irrigation techniques are suitable. Uniformity of application and resultant minimal water loss over the irrigated area are prime criteria of an irrigation system. These can be attained with level basins by balancing the basin size to the irrigation water supply and soil intake characteristics. The key factors in boosting irrigation efficiencies are suggested as: (1) using lasers to make the farm field as level as possible, (2) using special flumes and weirs to measure water flow, and (3) using automated gates to control the amount of water applied to a field.

78:03F-035
TAILWATER PITS GAIN POPULARITY IN TEXAS,
Blair, J.
Big Spring, Texas.
Irrigation Age, Vol. 12, No. 7, p 70-71, April, 1978. 4 fig.

Descriptors: Tailwater, Silts, Irrigation, Water conservation, Irrigation practices, Crop production, Water shortage.

Tailwater pits are one of the best methods yet devised to save irrigation water on the hardlands of northwest Texas and eastern New Mexico. Interest in them is still high, though the construction rate has slowed because of rising costs and the increase in sprinkler systems. In the recent years tailwater pits are designed according to the size of the field and amount of expected runoff with efficient silt traps. The report also suggests to check pump and motor occasionally to increase their efficiencies. It also suggests to irrigate alternate rows, learn when the crops go through stress periods, use limited tillage to reduce evaporation, improve tillage to reduce fuel costs, grow crops that use less water, and go back to terracing the fields if necessary.

78:03F-036
"NO ROOM FOR ERROR" SAYS YOUNG IRRIGATOR,
Irrigation Age, Vol. 12, No. 5, p 77, February, 1978.

Descriptors: Crop production, Management, Agriculture, Idaho, Potatoes, Fertilizers, Herbicides, Pesticides.

The total management approach towards agricultural crop production of a Idaho farmer was discussed. The approach includes frequent soil and plant testing, selection of good seed varieties, timely applications of fertilizers, herbicides, and pesticides of the right kind and amount including a good crop rotation program.

78:03F-037
STUBBLE BURN SCORES,
Irrigation Age, Vol. 12, No. 4, p 16, January, 1978.

Descriptors: Burning, Infiltration, Infiltration rates, Crop production, Economics, Adoption of practices, Comparative benefits, Comparative costs, Comparative productivity.

A study conducted at Texas A & M University compared plots where the straw was worked, where it was removed by bailing and where the straw and stubble was burnt off. The results showed that the difference in yields from the three types of plots was statistically insignificant. But the calculated annual savings from burning off each year rather than bailing or working back into the soil was $4.02/acre; whereas burning every other year and every third year could save $2.01 and $1.34/acre respectively. Another study involving infiltration rate showed that the infiltration rate for the burnt area was slower in the first hour, but increased later during a 22-hour period. Total infiltration for the period for the plot with straw worked in was 2.58 inches compared with 2.50 for straw removed and 2.28 inches for the burned area. The effect of straw disposal treatments on soil structure including changes in soil aggregates, bulk density, organic matter and compaction was studied. Results of dry and wet sieve analyses showed no significant differences among the three treatments.

78:03F-038
NEW MEXICO PUMP STUDY POINTS TO FARMERS' NEED FOR EFFICIENCY KNOWLEDGE,
Irrigation Age, Vol. 12, No. 4, p 34-35, 58, January, 1978. 3 tab.

Descriptors: Pump testing, Pumping plants, Pumps, Efficiencies, Natural gas, Operation and maintenance, New Mexico.

A New Mexico irrigation pump study suggests farmers should know more about pump efficiency and should have expert help in selecting pumps. Overall efficiency of a pumping plant, according to the report, should range from 15 to 20%. A study conducted by Texas Tech College which covered power requirements and efficiencies of 46 natural gas pumps revealed that only 6 pumps exceeded 15% overall efficiency while 16 had overall efficiencies below 10% and the average was 10.7%. The study conducted in New Mexico suggested that the average pump efficiency could be improved to 15% and thereby about 1.4 million cubic feet of natural gas used for irrigation pumping during an average year in New Mexico could be saved. This report also provides some guidelines for studying pumping plant efficiency.

78:03F-039
TENSIOMETERS TEACH HOW TO SAVE FUEL AND WATER,
Rodgers, N.
Littlefield, Texas.
Irrigation Age, Vol. 12, No. 4, p 45-46, January, 1978.

Descriptors: Tensiometers, Equipment, Data collections, Irrigation, Irrigation efficiency, Soil moisture, Moisture tension, Moisture content, Water conservation.

Tensiometers are valuable tools for the irrigator helping him to save money and water during the irrigation season. The irrigation schedule, based on soil moisture tension, can be varied during different periods of the growing season, depending upon the water requirements of the plant. However, they can mislead the irrigator if the tensiometers are not properly placed and maintained. Reading tensiometers daily has been suggested since it will indicate the danger of the tensiometers breaking suction and thus taking false readings can be avoided.

78:03F-040
DRAINAGE AND THE CENTER PIVOT SPRINKLER METHOD OF IRRIGATION,
Alvi, A.A.
Valmont International, Valley, Nebraska 68064.
ICID Bulletin, Vol. 27, No. 1, p 76-78, January, 1978. 7 ref.

Descriptors: Sprinkler irrigation, Irrigation, Drainage, Flooding, Salinity.

The surface method of flood irrigation is a source of drainage problems and it also does not provide controlled amounts of water to crops as and when required. The Center Pivot Sprinkler method of irrigation helps to solve these problems and has some other additional advantages. This method of irrigation in combination with integrated drainage construction is hoped to meet growing needs of food and fiber for the increasing world population.

78:03F-041
DEVELOPMENT OF AGRICULTURAL IRRIGATION IN THE FEDERAL REPUBLIC OF GERMANY,
Zanker, K.
Federal Ministry of Food, Agriculture and Forestry, Bonn, Regierungsdirektor.
ICID Bulletin, Vol. 27, No. 1, p 85-88, January, 1978. 3 tab, 4 ref.

Descriptors: Irrigation, Irrigation systems, Sprinkler irrigation, Water conservation, Water shortage, Arid climates, Semiarid climates.

Although the Federal Republic of Germany is situated in the temperate zone and owing to its quite high rainfall has no real water shortage in the strict sense of the term, modern irrigation methods do, however, offer the possibility of doing the available water supply more rationally and more economically. This is particularly true for years with low rainfall. In granting new water rights, the authorities should strive to reserve the supply of groundwater primarily for drinking purposes. In most cases for irrigation, surface water or effluent is sufficient (the latter, of course, subject to standards of hygiene being met). The results of the present paper can be usefully applied to areas where a real water shortage exists-arid and semi-arid zones of the earth. The more economical use of water available, made possible by more modern irrigation methods, which can lead to a considerable saving of water, can be of great importance, especially when water is in particularly short supply.

78:03F-042
STANDARDS FOR THE CALCULATION OF IRRIGATION EFFICIENCIES,
ICID Committee on "Assembling Irrigation Efficiency Data."
ICID Bulletin, Vol. 27, No. 1, p 91-101, January, 1978. 6 tab, 6 equ.

Descriptors: Standards, Irrigation efficiency, Irrigation, Irrigation ditches, Irrigation canals, Irrigated land, Irrigation design.

The efficient management of irrigation water is becoming more and more important as the competition for water of good quality grows ever keener with the world's increasing population. Reliable measurements of water are vital in preventing wastage and in the attainment of maximum beneficial use. Measurements should be made and records kept of all water flowing into and through the supply system and of all deliveries made from the system. Discharge measurements should be made as accurately as is practicable and action should be taken to restrain overdelivery. The purpose of this paper is to lay down a standard procedure for assessing efficiency of water use in conveyance, distribution and field application operations.

78:03F-043
DRIP SYSTEMS STANDARDS AND SPECIFICATIONS,
Irrigation Journal, Vol. 28, No. 3, p 12-13, 32, May-June, 1978.

Descriptors: Standards, Specifications, Irrigation, Irrigation systems, Water conservation, Irrigation design, Installation.

These standards and specifications of drip irrigation systems outlined by the Florida Irrigation Society contains useful information and guidelines for the irrigation industry.

78:03F-044
UNDER-TREE IRRIGATION SYSTEM,
Irrigation Journal, Vol. 28, No. 3, p 34, May-June, 1978.

Descriptors: Irrigation, Water conservation, Irrigation systems, Sprinkler irrigation, Drainage, Leaching.

A paper entitled, "Irrigation in the 21st Century-Today," which appeared in the May/June 1976 issue of the Irrigation Journal, dealt with the advantages of the Micro Jet and referred to it as the irrigation system of the future. The purpose of this paper is to describe an Israeli emitter, or minisprinkler which has been in operation for a number of years and also shows a great potential for the future.

78:03F-045
DRIP AND/OR SPRINKLER,
Olson, B.R., Jr.
Olson Engineering System, Indio, California.
Irrigation Journal, Vol. 28, No. 3, p 46-47, May-June, 1978.

Descriptors: Water conservation, Irrigation systems, Sprinkler irrigation, Water management (applied), Irrigation water, Filtration.

The purpose of this report is to discuss the various aspects of a drip irrigation system associated with its applicability and how it compares with a sprinkler irrigation system.

78:03F-046
COMPUTER SCHEDULING CAN SAVE MORE WATER,
Irrigation Age, Vol. 12, No. 6, p 17, March, 1978.

Descriptors: Irrigation programs, Scheduling, Irrigation efficiency, Water conservation, Computer models, Computer programs, Water management (applied), Nebraska, Irrigation systems.

It is reported that scheduling of irrigation water application through the use of electrical resistance blocks to determine soil moisture content, with data feedback to a computer system, can save up to 38% of the water and energy being used in most irrigation operations without reducing yields. One such irrigation scheduling computer program developed at the University of Nebraska-Lincoln has been discussed in this report.

78:03F-047
BETTER WATER USE, SAYS TEXANS,
Blair, J.
Big Spring, Texas.
Irrigation Age, Vol. 12, No. 6, p 26, March, 1978.

Descriptors: Water conservation, Irrigation, Irrigation wells, Texas, Irrigation efficiency, Grain sorghum, Cotton, Drought resistance, Surface irrigation, Sprinkler irrigation.

Irrigation on the Southern High Plains will continue the trends started a few years ago when production costs escalated. There will be greater emphasis on irrigation efficiency, more timely watering, fewer irrigations, and a slow-down in buying of new equipment. Also there will be a shift in crop acreages, with some of the corn and wheat land being put in milo and cotton. Consensus of opinion of the farmers is that despite higher irrigation costs most farmers will pump the wells in 1978. But there will be continued improvement in pumping efficiency, more water conservation methods used, more dependence on rainfall and a shift to drought resistant crops, such as cotton and grain sorghum.

78:03F-048
CORN YIELDS FROM IRRIGATION WITH ADEQUATE AND DEFICIENT WATER,
Kroutil, W.F.
Nebraska University, North Platte, Department of Agricultural Engineering.
Paper No. 78-2555, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 19 p. 11 fig, 2 tab, 25 ref.

Descriptors: Water management (applied), Corn (field), Moisture deficit, Yield equations, Crop response, Crop production, Growth stages, Evapotranspiration, Water conservation, Irrigation efficiency.

In 1974 and 1975, the effects of varying the time and the amounts of applied irrigation water on corn yield was studied on field plots at Fort Collins, Colorado. A single irrigation sprinkler line extending through the center of each plot provided the sole source of irrigation water. With this irrigation design, the corn experienced greater water deficiency outward from the sprinkler line. In addition, irrigation water was withheld from some treatments during various growth periods throughout the season. The field plots were preplant irrigated to wet the soil profile to a depth in excess of three meters. Primary comparisons were made of actual and/or relative yields of grain and dry matter for different water application amounts and for evapotranspiration. Omitting irrigation water during certain growth periods generally reduced yields. High soil water holding capacity reduced the necessity for frequent irrigation. Omitting all irrigations during two growth periods reduced yields substantially. Omitting irrigations was not always detrimental if adequate water was available in the soil profile to maintain adequate evapotranspiration. Of major significance was the result that, with few exceptions, regular application of less irrigation water than that required for maximum evapotranspiration produced the best water use efficiencies expressed as yield-per-unit of water consumptively used.

78:03F-049
IRRIGATE--A SCHEDULING MODEL,
Tscheschke, P., Gilley, J.R., Thompson, T., and Fischbach, P.
Nebraska University, Lincoln, Department of Agricultural Engineering.
Agricultural Engineering, Vol. 59, No. 1, p 45-46, January, 1978. 1 fig, 4 ref.

Descriptors: Water conservation, Scheduling, Irrigation, Computer models, Timing, Crop production, Computer programs, Crop production, Evapotranspiration, Climatic data, Irrigation systems.

Irrigation is a major consumer of the three scarce commodities: energy, water, fertilizer. The need for conservation through good irrigation management practices is urgent. To help meet these needs, University of Nebraska has developed an irrigation scheduling program called IRRIGATE for its AGNET (Agricultural Computer Network) system. The network serves the Institute of Agriculture and Natural Resources at the University of Nebraska-Lincoln and benefits the agricultural community directly. As with all AGNET models, IRRIGATE is designed for teaching, research and extension work. Access to AGNET can be made through small portable computer terminals. These are priced from $2000 and are about the size and shape of a portable typewriter. IRRIGATE records a field's soil moisture status since planting and answers the important questions of when and how much water should be applied in future irrigations. IRRIGATE is designed to be user oriented. IRRIGATE can be used with a wide variety of irrigation systems, with nine commonly grown area crops, with eight common soil types and with a minimum of climatic data (maximum and minimum temperature only) if necessary. The irrigation scheduling for about 25,000 acres was handled through IRRIGATE and AGNET in 1977.

78:03F-050
DRIP IRRIGATION-CHEMICAL, PHYSICAL WAYS TO KEEP EMITTERS OPEN,
Crops and Soils Magazine, Vol. 30, No. 6, p 15-18, March, 1978. 9 fig.

Descriptors: Maintenance, Clogging, Irrigation systems, Water conservation, Treatment, Chemical precipitation.

The most serious problem in drip irrigation is plugging of emitters caused by chemical or biological buildup in minute water passageways. Preventing that buildup is a key to successfully operating most drip irrigation systems. Researchers at Yuma and Phoenix, Arizona approached the clogging problem and reclaimed old drip lines by adding dilute H_2SO_4 and hypochlorite solution (laundry bleach) to the irrigation water entering the lines. After the initial "slug" treatment, the emitters were operating at 95% of the designed flow. After the 24- to 36-hour treatment, the entire system was treated with lower concentrations of chlorine and acid, keeping the system at about 1 ppm chlorine and a pH of 7. That continuous treatment maintained satisfactory emitter performance, not only in the older lines but in a newly installed system. More research is being done to expand guidelines for maintaining emitter performance.

78:03F-051
LIMITED IRRIGATION TESTS GET RESULTS,
Irrigation Age Magazine.
Irrigation Age, Vol. 12, No. 8, p 72-74, May-June, 1978. 2 fig.

Descriptors: Water conservation, Moisture deficit, Growth stages, Timing, Corn (field), Irrigation practices, Sorghum, Soybeans, Kansas, Nebraska.

Limited irrigation experiments were conducted in Kansas and Nebraska on corn, sorghum and soybean. It was observed by the researchers in the two states that corn yield was reduced by limiting irrigation at any stage of growth but a single irrigation was most effective just before the silking stage. With soybeans, they observed that the most critical period was at the beginning of pod development, whereas with sorghum, the timing of irrigation was not found to be important which gives it a management advantage when using limited water. The experiments showed that the limited irrigation techniques help in saving water, energy and irrigation equipment wear and tear.

78:03F-052
HOW IDAHO IRRIGATORS TRIM BACK POWER COSTS,
Henry, C.
Irrigation Age Magazine.
Irrigation Age, Vol. 12, No. 8, p 82-84, May-June, 1978.

Descriptors: Scheduling, Irrigation, Irrigation practices, Electric power costs, Fertilizers, Water conservation, Crop production, Idaho, Water management (applied).

The benefits obtained by an Idaho farmer by irrigation scheduling were reported. Irrigation scheduling has not only helped to keep the power cost down but also it has reduced labor-hour requirement, leaching of fertilizers and has resulted in increased yields. One other additional advantage was in management operations, such as thinning and cultivations, during periods indicated by favorable moisture content.

78:03F-053
FLOAT VALVES IMPROVE PIPELINE SYSTEMS,
Humpherys, A.
Snake River Conservation Research, Agricultural Engineering Division, Kimberly, Idaho.
Irrigation Age, Vol. 12, No. 7, p 12-15, April, 1978. 1 fig, 1 tab.

Descriptors: Water conservation, Floats, Valves, Flow control, Pipelines, Water shortage, Irrigation efficiency.

Water shortages and rising energy and labor costs are forcing irrigators to look for ways to increase irrigation efficiency and reduce operating costs. To accomplish this, they need maximum system flexibility and ease of operation. Many low pressure pipeline systems can be improved by using float valves to provide better and easier water control. Float valves are relatively new and since most of them are used in California where they were developed, many farmers are not familiar with them. This paper discusses the applicability of float valves in various situations of field irrigation systems.

78:03F-054
DISTRIBUTION PATTERNS AND LOSSES FOR FURROW IRRIGATION,
Karmeli, D.
Colorado State University, Fort Collins, Department of Agricultural and Chemical Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, p 59-68, March, 1978. 4 fig, 1 fig, 10 ref, 22 equ, 1 append.

Descriptors: Furrow irrigation, Surface irrigation, Distribution patterns, Irrigation efficiency, Model studies, Mathematical models, Recession curves, Infiltration, Runoff.

A model was developed to describe the distribution patterns and efficiencies for furrow irrigation. The model consisted of the following: (1) A frequency curve of the dimensionless infiltration depth (actual infiltered depth/desired infiltration depth), versus fractional length of run (distance from end of field/ total length of field); (2) Description of the frequency curve by a mathematical model that enables the comparison of systems by using the model to establish the various efficiencies and other statistical parameters such as the deviation from desired application depth. The model, based on the power curve fit for surface irrigation systems, was found to be a good representation of actual patterns of distribution in an irrigated field. The model suggested allows for integration of the various functions related to irrigation performance such as water-yield function.

78:03F-055
STRAW-MULCH RATE EFFECT ON SOIL WATER STORAGE AND SORGHUM YIELD,
Unger, P.W.
United States Department of Agriculture, Southwestern Great Plains Research Center, Bushland, Texas 79012.
Soil Science Society of America Journal, Vol. 42, No. 3, p 486-491, May-June, 1978. 4 fig, 3 tab, 12 ref.

Descriptors: Mulching, Water conservation, Moisture availability, Grain sorghum, Moisture content, Fallowing, Crop response.

A field study was conducted to determine the effects of straw mulch rates on soil water storage during fallow and on subsequent grain sorghum production. Wheat straw at rates of 0(check), 1, 2, 4, 8, or 12 metric tons/ha was placed on field plots in July 1973, 1974, and 1975. A different area, previously cropped to dry-land wheat, was used each year. Atrazine (2-chloro-4(ethylamino)-6(isopropylamino)-s-triazine) was applied for volunteer wheat and weed control before mulch placement. Soil water content was measured periodically from July until the following May, when grain sorghum was planted, and during the sorghum growing season. Available soil water at planting averaged 12.3 and 21.4 cm for the 0- and 12-metric tons/ha mulch treatments, respectively. The additional water, along with greater infiltration and lower evaporation during the growing season, increased grain yields, which averaged 1,780 and 3,990 kg/ha for the respective treatments. Water-use efficiency increased from 55.6 kg/ha-cm for no mulch to 115.0 kg/ha-cm for 12 metric tons mulch/ha.

78:03F-056

A SOIL-WATER-NITROGEN MODEL FOR IRRIGATED CORN ON SANDY SOILS,

Watts, D.G., and Hanks, R.J.
Nebraska University, Lincoln, Department of Agricultural Engineering.
Soil Science Society of America Journal, Vol. 42, No. 3, p 492-499, May-June, 1978. 8 fig, 25 ref, 20 equ, 1 append.

Descriptors: Nitrogen, Nitrates, Leaching, Model studies, Soil-water-plant relationships, Sweet corn, Diffusion, Convection, Water balance, Irrigation.

A model was developed which describes the net changes of nitrogen amounts due to transformations and the movement, uptake, and loss of nitrogen from the root system of irrigated corn (Zea mays L.) grown on sandy soils. A potential nitrogen uptake function developed from field data is used to determine the maximum uptake for nonlimiting soil water and nitrogen availability. Actual uptake is calculated as less than potential when soil water content and/or mineral nitrogen concentration and distribution limit convective and diffusive movement of nitrate to the root system. Separate calculations are made for uptake resulting from each of these two mechanisms. Seasonal nitrogen uptake was computed within ±15% of measured uptake on field plots where uptake by above ground plant material ranged from 105 to 218 kg/ha. Computed nitrate leaching losses compared favorably with losses estimated by multiplying percolation loss determined from a weekly water balance, by measured nitrate concentration at 150 cm depth. Field leaching losses estimated by the water balance-concentration method ranged from 37 to 154 kg/ha.

78:03F-057

NITROGEN SOURCES FOR HAY PRODUCTION ON FLOODED MEADOWS,

Ludwick, A.E., Rumburg, C.B., and Siemer, E.G.
Colorado State University, Fort Collins, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 509-512, May-June, 1978. 7 tab, 13 ref.

Descriptors: Nitrogen, Nitrogen compounds, Ammonium compounds, Fertilizers, Ureas, Nitrates, Denitrification, Hay, Flooding, Volatility.

Three experiments were conducted over a 3-year period to compare various urea materials and ammonium nitrate as N sources for hay production on flooded meadow sites. Each experiment was a complete factorial combination of fertilizer N sources and rates broadcast once in the spring on established forage prior to flood irrigation. The N sources in these experiments consisted of ammonium nitrate, urea, sulfur-coated urea, urea ammonium polyphosphate and urea ammonium sulfate. Hay yields and N uptake were significantly increased by N fertilizer at each location; there was no significant response in hay yield or N uptake resulting from residual N in the second season of Experiment 1. Source of N did not influence hay yields nor N uptake. The N content of the hay was significantly influenced by the N fertilizer rate at two locations and the N source at one location. In general, hay yields and N uptake increased with increasing rates of fertilizer N. Fertilizer efficiency was low at all locations, ranging between 8.5 and 19.6 kg hay/kg N. Fertilizer N recovery was <30% for all treatments. Both efficiency and recovery of N tended to decrease with increasing N rates.

78:03F-058
COMPUTER PROGRAMMING SOLID SET SYSTEMS,
Griffin, S.G.
The Toro Company, Riverside, California.
Paper No. 78-2012, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 9 p.

Descriptors: Sprinkler irrigation, Uniformity coefficient, Computer programs, Water shortage, Testing, Simulation analysis, Nozzles, Water pressure, Design criteria, Irrigation efficiency.

Solid set sprinkler system uniformity is of great importance in today's agriculture. A computer program for evaluating sprinkler performance has been developed. This program has shown to be valuable in product development as well as providing more accurate information on system operation to the grower in the field.

78:03F-059
CONTOUR FURROW IRRIGATION WITH LIQUID MANURE USING "MICROTUBING" FOR FLOW CONTROL,
DeTar, W.R.
Pennsylvania State University, University Park, Department of Agricultural Engineering.
Paper No. 78-2027, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 45 p. 15 fig, 9 tab, 4 ref, 78 equ.

Descriptors: Contour furrows, Furrow irrigation, Fertilizers, Liquid wastes, Flow control, Irrigation systems, Irrigation, Water management (applied).

The trickle-furrow concept is introduced. The low infiltration rate of dilute liquid manure makes possible 100 ft lengths of run with only 0.3 gpm/furrow. Furrows can run 8 hrs/set. Proposed is a solid-set arrangement of 1000 ft of corrugated plastic tubing laterals descending 5-10% slopes with microtubing outlets at each furrow. Field experiment yields rate-of-advance curves. A prediction equation is given for length of run. Friction loss data are presented. Work is still in progress.

78:03F-060
MANAGEMENT FOR MINIMIZING NITROGEN LEACHING LOSSES ON IRRIGATED SANDY SOILS,
Watts, D., Martin, D., Tscheschke, P., and England, M.
Nebraska University, Lincoln, Department of Agricultural Engineering.
Paper No. 78-2025, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 22 p. 14 fig, 8 ref.

Descriptors: Nutrient removal, Nitrogen, Nitrates, Leaching, Organic matter, Water management (applied), Nitrogen fixation, Corn (field), Nebraska, Soil texture.

A model study was made to evaluate nitrogen uptake and the loss of water and nitrate from the root zone of irrigated corn on sandy soils in Western Nebraska. Three N sources, two N amounts and a wide range of irrigation applications were simulated for growing seasons with normal and 75 percent above normal rainfall. Control of irrigation amounts to minimize percolation and proper selection of nitrogen amount and source all had a significant effect on nitrate leaching loss.

78:03F-061

PEACH TREE RESPONSE TO DRIP APPLICATION OF WATER AND NUTRIENTS,

Chesness, J.L., and Couvillon, G.A.
Georgia University, Athens, Department of Agricultural Engineering.
Paper No. 78-2019, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 19 p. 1 fig, 4 tab, 36 ref.

Descriptors: Irrigation systems, Crop response, Crop production, Peaches, Water management (applied), Fertilization, Nutrients, Nutrient requirements, Irrigation, Southeast United States.

Two years of peach tree response to drip irrigation were reported on. Four treatments involving two water regimens and two water applied fertilizer rates were investigated. Yield in kg/cm trunk diameter/tree averaged 43 percent higher for the irrigated treatments. There was no significant differences in the yield and elemental leaf tissue levels for trees receiving one-half levels of nutrients applied through the system.

78:03F-062

QUANTIFICATION OF RICE YIELD BENEFITS ATTRIBUTABLE TO IRRIGATION WATER,

Bhuiyan, S.I., and Sumayao, A.
International Rice Research Institute, Los Banos, Laguna, Philippines, Department of Irrigation and Water Management.
Paper No. 78-2022, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 12 p. 15 fig, 1 tab, 16 ref.

Descriptors: Rice, Irrigation, Water management (applied), Moisture stress, Crop response, Crop production, Yield equations, Regression analysis, Management, Irrigation effects.

An experiment with a split-plot design was conducted at three different locations to grow LR-36 variety of rice in the dry season when no crop can be grown without irrigation water in order to quantify rice yield benefits due to irrigation under farmers' field condition. Five irrigation treatments, representing various degrees of water stress during the reproductive growth stage of the crop, were imposed in the main plots and three management package treatments, representing the average farmer's level, intermediate level and high level use of other inputs, were imposed in the subplots. High level of management combined with adequate water produced about 5.1 t/ha, whereas farmer level management under adequate water yielded 2.9 t/ha. Yield was reduced consistently as stress days increased. An average of thirty one stress days caused a yield reduction of 1.0 t/ha under the farmer level management, but an average reduction of about 1.5 t/ha under the two higher level managements. A regression model developed showed that the location of the experiment had no significant effect on the yield. The model predicts yield variation due to stress days and level of management. Management was found to have a much stronger influence on yield than water stress.

78:03F-063

POTATO AND LETTUCE RESPONSE TO IRRIGATION METHODS AND PRACTICES,

Sammis, T.W., and Hanson, E.G.
New Mexico State University, Las Cruces.
Paper No. 78-2020, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 11 p. 2 fig, 7 tab, 9 ref.

Descriptors: Irrigation practices, Irrigation systems, Surface irrigation, Subsurface irrigation, Sprinkler irrigation, Potatoes, Lettuce, Irrigation efficiency, Crop response, Crop production.

Spring potatoes and fall lettuce were irrigated with sprinkler, trickle, subsurface, and furrow irrigations for two consecutive years. Results are presented that pertain to the influence of these methods on crop yield, water-use efficiency, quality at maturity, and the variability of measurements. The lowest irrigation ratio for two consecutive years was achieved by trickle and subsurface.

Water-use efficiency was indeterminate for the 1975 lettuce cropping year. In 1976, lettuce that was subsurface irrigated resulted in the highest water-use efficiency. Potatoes subsurface and trickle irrigated resulted in the highest water-use efficiency in 1975, and those irrigated by subsurface irrigation resulted in the highest water-use efficiency in 1976.

78:03F-064
ASSESSING TRICKLE EMITTER APPLICATION UNIFORMITY,
Nakayama, F.S., Bucks, D.A., and Clemmens, A.J.
U.S. Water Conservation Laboratory, 4331 East Broadway, Phoenix, Arizona 85040.
Paper No. 78-2017, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 7 p. 6 fig, 2 tab, 4 ref, 14 equ, 2 append.

Descriptors: Irrigation systems, Uniformity coefficient, Water conservation, Application methods, Irrigation efficiency, Sprinkler irrigation, Statistical methods, Flow rates, Frequency curves, Irrigation.

A method was developed for showing the uniformity of water application by trickle emitters based on the emitter's coefficient of variation. The derived design uniformity coefficient equation for different numbers of emitters per plant was related to the uniformity coefficient used in sprinkler irrigation. The interrelationship between the computed design uniformity coefficient, the manufacturer's coefficient of variation for the emitter, and the number of emitters per plant can be used as a guide for selecting the number of emitters per plant. In addition, a field uniformity coefficient and a field emitter coefficient of variation were related to the fraction of plants adequately irrigated.

78:03F-065
DRIP IRRIGATION OF ORANGE TREES IN HUMID CLIMATE,
Myers, J.M., and Harrison, D.S.
Florida University, Gainesville, Department of Agricultural Engineering.
Paper No. 78-2018, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 7 p. 9 tab, 8 ref.

Descriptors: Sprinkler irrigation, Irrigation systems, Oranges, Humid climates, Fertilization, Citrus fruits, Crop production, Irrigation, Statistical methods, Florida.

Results of a four-year study of drip and overhead sprinkler irrigation on orange trees grown in Florida on a sandy soil indicate responses are highly dependent on rainfall amounts and characteristics. For a year with rainfall 28% below normal average yields from trees with 2, 4 and 6 emitters/tree were 4.00, 4.24 and 4.83 boxes/tree, respectively. Yields for sprinkler and no irrigation checks were 4.41 and 2.37 boxes/tree. Differences in yield between the three drip irrigation treatments and the sprinkler check were not significant at the 95% confidence level, however, all four of these treatments were significantly better than the no irrigation check. Average yields for quantities of water for drip irrigation were 4.13, 5.16 and 5.43 boxes/tree for low medium and high amounts, respectively. The statistical significance of the water quantity results are identical to those for the emitter density results. Supplemental fertilizer application, through the drip water distribution system, of 19-0-19 k/ha/year and 38-0-38 k/ha/year of N-P-K did not appear to influence yields of oranges. Irrigation treatments did not significantly affect production in years with average or above average rainfall. Juice content and quality was not influenced by irrigation treatment or rainfall.

78:03F-066
A SOLAR-POWERED PUMP FOR IRRIGATION,
Alexander, G.H.
Battelle Memorial Institute, Columbus, Ohio, Columbus Laboratories.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 1-19, February 26-28, 1978. 8 fig.

Descriptors: Pumps, Pumping plants, Irrigation, Energy conversion, Economic feasibility.

A solar-powered irrigation pump designed for the Northwestern Mutual Life Insurance Company by Battelle Memorial Institute has been in experimental and developmental operation at Northwestern Mutual's Paloma Ranch near Gila Bend, Arizona, since April 1977. An objective of this program was to design and construct a prototype 35- to 50-horsepower solar-energy pumping system to evaluate its applicability in a working irrigation environment. The range includes approximately 22,000 irrigated acres; the yearly energy bill for pumping water is approximately $1.5 million.

78:03F-067
ENERGY AND IRRIGATION,
Oostermeyer, J.S.
Shell Chemical Company, Houston, Texas.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 20-27, February 26-28, 1978.

Descriptors: Energy, Energy conversion, Irrigation, Agriculture, Irrigation practices, Pesticides, Fertilizers, Nuclear energy, Oil, Natural gas.

This paper reviews the energy situation in the United States and how the energy shortage is going to affect the national economy, thereby, the irrigated agriculture. It also suggests the directions of a sound national energy policy to deal with the situation and recommends better farm management practices to reduce the cost of energy in irrigated agriculture.

78:03F-068
SOLID STATE CONTROL SYSTEMS FOR IRRIGATION,
Marian, M.B.
Solar Wind Systems, Incorporated, San Rafael, California.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 35-37, February 26-28, 1978.

Descriptors: Irrigation programs, Irrigation, Scheduling, Control systems, Automatic control, Computer programs, Computer models.

This paper discusses the basic principles of solid state control systems, causes of failure or malfunction of the systems, customer's responsibilities to insure proper function, and their applicabilities in irrigation scheduling. Further, it discusses three basic ways to program an irrigation controller and recommends the use of removable media such as programming with a mark sense card.

78:03F-069
ELECTRICAL LOAD AND WATER MANAGEMENT,
Heermann, D.F., and Duke, H.R.
Science and Education Administration, Fort Collins, Colorado, United States Department of Agriculture.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 60-67, February 26-28, 1978. 4 fig, 9 ref.

Descriptors: Load distribution, Electric power demand, Water management (applied), Peak loads, Sprinkler irrigation.

The objective of this paper is first, to review the presently used techniques for reducing peak demands on electrical systems, second, to examine a technique for improving the water management of center pivot sprinkler systems and, third, to explore the integration of load management and water management. An analysis of these aspects led to the conclusion that an integrated load and water management control system offers significant cost savings to today's irrigator.

78:03F-070
CENTER PIVOTS ON SOILS MARGINALLY SUITED FOR IRRIGATION IN MANITOBA, CANADA,
Penkava, F.F.
Manitoba University, Winnipeg, Manitoba, Canada, Department of Agricultural Engineering.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 68-75, February 26-28, 1978. 3 fig, 7 ref.

Descriptors: Sprinkler irrigation, Irrigation effects, Soil classification, Productivity, Crop production, Soil erosion, Runoff, Potatoes, Soil physical properties, Canada.

The Almasippi series soils of Manitoba have poor moisture holding capacity and high groundwater tables. In spite of those very serious disadvantages irrigated potato production will likely expand on the Almasippi soils. In order to acquire more knowledge on the proper use of center pivot irrigation and on the possible problems and measures for their elimination, a research project was initiated in the spring of 1977 on two localities on which center pivot units were just being installed. The following preliminary conclusions were made based on the research findings: (1) Center pivots, or any other irrigation systems used on the Almasippi series soils in Manitoba must be carefully designed and operated; (2) Single applications should not exceed 20 mm; (3) Application intensities must be carefully balanced with infiltration capacities of the soils and no credit must be given to surface water detention; (4) In carbonated areas application intensity should not exceed 5 mm per hour (0.2 inch/hr); (5) Oversized center pivot units with high precipitation intensities near the end tower should not be used; (6) Random subsurface drainage should be used to control the groundwater levels in the depressions; and (7) Research should continue under real irrigation conditions.

78:03F-071
APPLICATION OF END GUNS ON CENTER PIVOTS,
Hanson, R.E.
Nelson Irrigation Corporation, Grand Island, Nebraska.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 91-103, February 26-28, 1978. 8 fig.

Descriptors: Sprinkler irrigation, Uniformity coefficient, Distribution patterns, Drops (fluids), Application equipment, Crop production, Water management (applied).

The main factors probably considered by the pivot irrigator in selecting the use of end guns are the favorable cost per acre and obtaining the maximum corner coverage. Use of end guns in combination with corner covering type systems, end gun sizes in combination and larger end guns have been more recent adaptations on center pivots to extend the corner coverage. Many factors affect the corner coverage obtainable with an end gun. Some of these factors can only be determined through a complete system design for the conditions. Selection of the end gun for the system conditions are based primarily on the gun performance, arc setting, pressure, trajectory angle and nozzle size. Proper application of end guns generally involves the same field, soil, crop, climatic and water supply conditions that must be considered in center pivot application. In addition to obtaining maximum effective corner coverage, other considerations are uniformity of application, droplet impact conditions and application rate. This paper discusses the factors affecting these considerations in the use of end guns on center pivot systems.

78:03F-072
LIMITS OF LOW PRESSURE SPRINKLERS AND SPRAY NOZZLES ON CENTER PIVOT APPLICATIONS,
Gilley, J.R.
Nebraska University, Lincoln, Department of Agricultural Engineering.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 104-115, February 26-28, 1978. 6 fig, 3 tab, 9 ref, 1 equ.

Descriptors: Sprinkler irrigation, Limiting factors, Nozzles, Application equipment, Uniformity coefficient, Pressure head, Irrigation efficiency, Runoff, Soil erosion.

Low pressure center pivot irrigation systems offer the potential of applying irrigation water with significant energy savings. However, lowering the pressure of center pivot systems may create potential problems of runoff and soil erosion, uniformity of water application and operation. The future use of low pressure systems is dependent upon the solutions of these problems. In some cases low pressure systems should not be used. This paper presents an analysis and discussion of the effects of lower pressures on center pivot applications.

78:03F-073
SCHEDULING OF WATER AND NITROGEN FOR CORN IN THE HUMID MIDWEST,
Vitosh, M.L.
Michigan State University, East Lansing, Crop and Soil Science Department.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 116-123, February 26-28, 1978. 1 fig, 4 tab, 11 ref.

Descriptors: Scheduling, Irrigation, Water management (applied), Sweet corn, Nitrogen, Fertilization, Humid climates, Michigan.

This study was conducted in Michigan on irrigated sandy soils where irrigation of corn is a relatively new practice compared to the semi-arid regions. It was recommended that application rate should not exceed 30% of the water holding capacity in the effective rooting zone since the optimum soil moisture level for corn is usually between 50 and 80% of the available water holding capacity. This will prevent or minimize the leaching of nitrate-nitrogen from the rooting zone in the event of rain. Adequate moisture must be available at the end of the growing season to carry the crop to maturity. Further, it was recommended to apply approximately one-third of the total N requirement for the crop as: (a) preplant incorporated or pre-emergence with a herbicide; (b) one-third sidedress or pre-emergence if the first third was applied preplant; and (c) one-third through the irrigation system which should be applied prior to pollination.

78:03F-074
THE ROLE OF SPRINKLER IRRIGATION IN PRODUCING SPECIALTY CROPS,
Patterson, C.
Patterson Farms, China Grove, North Carolina.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 124-125, February 26-28, 1978.

Descriptors: Sprinkler irrigation, Frost protection, Freezing, Tomatoes, Strawberries, North Carolina.

The benefits of using a solid set sprinkler irrigation system for frost and freeze protection of tomato and strawberry production in North Carolina were discussed.

78:03F-075
THE USE OF OVERTREE IRRIGATION FOR CROP COOLING AND FROST AND FREEZE PROTECTION ON APPLES,
Unrath, C.R., and Sneed, R.E.
North Carolina State University, Raleigh, Department of Horticultural Science.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 131-134, February 26-28, 1978.

Descriptors: Sprinkler irrigation, Cooling, Freezing, Frost protection, Apples, Peaches, Fruit crops, North Carolina.

Overtree irrigation for apple orchard cooling has proven to be an effective method of microclimate modification resulting in markedly improved fruit quality and greater grower returns. The experimental results showed that the evaporative cooling resulted in increased fruit coloration of red varieties' apples and increased sugar content, fruit size and reduced incidence of cork spot and bitter pit. The application rates of 0.16 in/hr to 0.18 in/hr were found to be effective and to provide higher water use efficiency than lower application rates. Overtree irrigation for frost and freeze protection was also evaluated and application rate between 0.16 in/hr to 0.18 in/hr was recommended for severity of freeze conditions.

78:03F-076
OPTIMIZING TRAVELING SPRINKLER SYSTEM PERFORMANCE,
Rupar, B.
Nelson Irrigation Corporation, Walla Walla, Washington.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 152-159, February 26-28, 1978. 5 fig, 1 tab, 2 equ.

Descriptors: Sprinkler irrigation, Uniformity coefficient, Application equipment, Pressure head, Distribution pattern, Wind velocity.

Many factors affect the proper performance of traveling sprinkler irrigation systems. Among the most important considerations are uniformity of application, water droplet conditions and the application rate of the system. Test data, as well as actual field experience, confirms that a high degree of uniformity is achievable with a traveler, as long as proper lane spacing and travel direction are utilized, as well as proper arc setting the pressure. Acceptable droplet conditions can be achieved only through the use of adequate pressure and proper selection of trajectory angle for a given nozzle size. Application rates for travelers are sufficiently low to make them adaptable for most soil conditions.

78:03F-077
INTRODUCTION TO IRRIGATION EFFICIENCY AND SCHEDULING,
Aljibury, F.K.
California University, Parlier, Cooperative Extension.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 160-161, February 26-28, 1978. 1 tab.

Descriptors: Irrigation efficiency, Scheduling, Water shortage, Sprinkler irrigation, Consumptive use, Agriculture.

The subject of rational use of water is of vital interest. The allocation of existing supplies of water is becoming difficult and controversial. Irrigation efficiency and scheduling concepts play important roles in this context.

78:03F-078
FACTORS INFLUENCING SYSTEM SELECTION IN HUMID REGIONS,
Curtis, L.M.
Auburn University, Auburn, Alabama, Alabama Cooperative Extension Service.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 126-130, February 26-28, 1978. 5 fig.

Descriptors: Irrigation, Humid areas, Humid climates, Southeast United States, Irrigation systems, Sprinkler irrigation.

Factors and difficulties that should be evaluated in considering cable tow and center pivot irrigation systems of farms in the Southeast United States were discussed. The following factors have been analyzed: (1) water supply; (2) topography and surface characteristics; (3) crops grown and rotation schemes; and (4) economic considerations. It was concluded that the factors influencing system selection in the Southeast are numerous. The less favorable factors may slow or prohibit development of irrigation in some areas. However, continued expansion of irrigated cropland appears likely as farmers incorporate irrigation as a production or management tool in their overall farming operation.

78:03F-079
SOCIETAL ATTITUDES AND RESULTANT POLICIES CALL FOR WATER CONSERVATION,
Hagan, R.M.
California University, Davis, Department of Land, Air and Water Resources.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 162-179, February 26-28, 1978.

Descriptors: Water conservation, Social aspects, Social impact, Social participation, Water policy, Agriculture, Irrigation practices, Irrigation efficiency, Evapotranspiration, California.

The water situation and, to some extent, societal attitudes have changed dramatically in California within the past few months. This paper briefly touches on a number of aspects in order to provide a sample of the kinds of thoughts being expressed about irrigation agriculture, especially by environmental leaders. Several points are covered in some detail. Hopefully, these comments will provide a useful indication of what some vocal elements in today's society are saying which bear on agricultural water conservation and on the irrigation industry.

78:03F-080
WATER EFFICIENCY WITH DEFICIT AND SUBOPTIMAL IRRIGATION,
Aljibury, F.K., Gerdts, M., and Beutel, J.
California University, Parlier, Cooperative Extension.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 180-182, February 26-28, 1978. 3 tab.

Descriptors: Cultural control, Water shortage, Water conservation, Irrigation, Furrow irrigation, Fruit crops, Water management (applied), Irrigation systems, Irrigation efficiency, California.

Irrigation is considered one of the most important cultural practices in the arid and semi-arid irrigated areas of the world. The increasing demand for water and its limited supplies requires maximum efficiency in its use for irrigation. To achieve this end, many water specialists and plant scientists have been conducting studies to determine the effect of deficit irrigation on the production of food and fibrous crops. The objectives of such experiments are to maximize production under conditions of drought or limited water supplies. The authors concluded from their experimental results that the effect of deficit irrigation by furrow irrigation on the early growth of the plum trees was not significant. The deficit irrigation did not cause unusual leaf abscission or premature fruit drop. Total production was not affected but water savings was significant. The effect of deficit water treatments in the drip irrigated plots, on the soil water potential and deep moisture extraction was found to be very evident. These irrigations did not effect the number of fruits per tree and bud initiation of future seasons significantly but produced fruits of smaller size.

78:03F-081
COMPARATIVE EFFICIENCY OF IRRIGATION SYSTEMS,
Shearer, M.N.
Oregon State University, Corvallis.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 183-188, February 26-28, 1978. 4 fig, 2 tab.

Descriptors: Irrigation efficiency, Irrigation systems, Uniformity coefficient, Sprinkler irrigation, Surface irrigation, Seepage, Runoff, Evaporation.

The purpose of this paper is to compare efficiencies obtainable with various irrigation systems having reasonably good designs. Also, several concepts of field irrigation efficiency have been discussed.

78:03F-082
IRRIGATION EFFICIENCY IN SCHEDULING,
Tribe, G.
Cornell Pump Company, Portland, Oregon.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 189-191, February 26-28, 1978.

Descriptors: Pumps, Pumping plants, Pump testing, Efficiencies, Design criteria.

Testing and experimentation have proven that a pump's ability to convert rotating kinetic energy to hydraulic pressure energy is predictable. This energy conversion efficiency can be improved by the application of proven engineering fundamentals. This paper discusses the need for improving pump efficiency and the factors which must be considered for improved pump design and to reduce the cost of ownership.

78:03F-083
AUTOMATION OF SURFACE IRRIGATION,
Eisenhauer, D.E., and Fischbach, P.E.
Nebraska University, Clay Center, South Central Station.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio,
p 196-205, February 26-28, 1978. 1 fig, 4 tab, 7 ref.

Descriptors: Surface irrigation, Automation control, Irrigation efficiency, Irrigation systems, Cost comparisons, Nebraska.

Efficient and low labor irrigation systems appear to be the way of the future. Automation of conventional gated pipe systems is a good way of improving efficiency and yet holding down labor requirements. The main additional component of the automatic system is the automatic valve. One such valve is on the market now and another will be available soon. Design of automatic systems involves properly sizing pipeline and other components, using normal engineering criteria, plus designing for the proper field length and furrow stream size. Annual costs of automatic gated pipe is higher than conventional gated pipe systems, but recent trends in automatic sprinkler systems suggest that farmers are willing to invest the extra capital to reduce labor demands.

78:03F-084
PRACTICAL SURFACE IRRIGATION,
Gosling, R.
West Side Pump Company, Dos Palos, California.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 206-208, February 26-28, 1978.

Descriptors: Surface irrigation, Sprinkler irrigation, Irrigation systems, Automation, Cost comparisons, Flexibility, California.

This paper discusses and makes a comparative analysis of gated pipe surface irrigation systems with respect to other systems.

78:03F-085
MEASURING EFFICIENCY OF SURFACE IRRIGATION SYSTEMS,
Robinson, S.C.
Bennett & Bennett Irrigation Pipe Company, Hanford, California.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 209-212, February 26-28, 1978.

Descriptors: Surface irrigation, Irrigation efficiency, Application methods, Application equipment, Return flow, Irrigation systems, Measurement, Border irrigation, Furrow irrigation, Sprinkler irrigation.

The reasons behind the concept of irrigation efficiency, the definition of application efficiency, and the various components of efficiency measurement of surface irrigation systems were discussed. Moreover, the rules of thumb were outlined which could be used in field applications to attain high application efficiency of surface irrigation systems.

78:03F-086
SOLAR CELL IRRIGATION,
Fischbach, P.E., and Matlin, R.W.
Nebraska University, Lincoln, Department of Agricultural Engineering.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 213-217, February 26-28, 1978. 1 fig, 2 tab.

Descriptors: Irrigation, Energy, Energy conversion, Irrigation systems, Surface irrigation, Automation, Computer programs, Irrigation programs, Nebraska, Application equipment.

In the first project of its kind, the largest solar cell-powered crop irrigation system on earth has been constructed on the University of Nebraska field laboratory in Mead, Nebraska. Success of the experimental irrigation system could demonstrate an alternate source of energy for irrigation. A discussion about the photovoltaic solar cells used in the project, how they converted the solar energy to electrical energy and how the 80 acre-irrigation project was run and managed by the system were discussed.

78:03F-087
EVALUATION CRITERIA FOR TRICKLE IRRIGATION EMISSION DEVICES,
Solomon, K.
Rain Bird Technical Services, Logan, Utah.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 218-225, February 26-28, 1978. 4 ref.

Descriptors: Irrigation, Irrigation systems, Trickling filters, Clogging, Pressure head, Variability, Costs, Risks.

The emission device is sometimes referred to as the heart of a trickle irrigation system. It is important to compare carefully the different types of emission devices available in order to choose wisely from among possible alternatives. This paper suggested and discussed some of the factors to be considered when judging and comparing emission devices. The author suggested that the following seven fundamental factors should be examined to select a particular emission device to use in a system: (1) General suitability; (2) Pressure-flow relationships; (3) Manufacturing variability; (4) Flow rate sensitivity to water temperature; (5) Sensitivity to clogging; (6) Cost and (7) Risk. Some of these can be considered engineering performance factors, and hence can be measured and evaluated only subjectively.

78:03F-088
TRICKLE DESIGN FOR MIDWEST CONDITIONS,
Gamble, J.
Farm Bureau Services, Incorporated, Hart, Michigan.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 226-230, February 26-28, 1978.

Descriptors: Irrigation, Irrigation systems, Irrigation design, Irrigation operation and maintenance, Clogging, Pipelines, Water shortage, Water conservation.

This paper discussed trickle irrigation design concepts, water resources used for this system in the midwest United States, and installation and operation criteria for such a system. Current problems facing the users and/or the installer of the system were also discussed.

78:03F-089
TRICKLE IRRIGATION IN HUMID ZONES,
Braud, H.J.
Louisiana State University, Baton Rouge, Department of Agricultural Engineering.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 231-238, February 26-28, 1978. 2 fig, 2 tab, 6 ref.

Descriptors: Irrigation systems, Irrigation, Irrigation design, Humid areas, Louisiana, Productivity, Citrus fruits, Sugarcane.

The need for irrigation in a humid area is specific to the particular crop-soil-climate. Not all crops respond to irrigation: Citrus does, but not sugarcane in Louisiana. Work group meetings of scientists interested or involved in trickle irrigation were held last year to define the most important problems of trickle irrigation. A regional research project draft was written, "Trickle Irrigation in Humid Regions," with the following objectives: 1) To determine water requirements and water management techniques; 2) To develop best procedures for applying N, P and K; 3) To determine causes of clogging in humid regions and develop methods to minimize it; 4) To optimize crop management practices; 5) To examine water and nutrient flow patterns and related root development; 6) To examine the costs, returns and profitability of trickle irrigation. Research on trickle is underway or planned at 17 state agricultural experiment stations and United States Department of Agriculture, Agricultural Research Service research stations in Louisiana.

78:03F-090
BACTERIAL CLOGGING IN LOW PRESSURE IRRIGATION SYSTEMS,
Ford, H.W.
Florida University, Lake Alfred, Institute of Food and Agricultural Sciences.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 239-244, February 26-28, 1978. 2 fig, 7 ref.

Descriptors: Irrigation systems, Low-flow augmentation, Clogging, Irrigation, Bacteria, Slime.

Bacterial slimes are the fundamental cause of most clogging problems. There are no types of low pressure irrigation systems immune to slime clogging. Chlorine, when used in combination with suitable filtration, will control most of the slimes and associated agents that clog irrigation emitters. Chlorine, like other pesticides, requires a special use label in order to be used in drip irrigation systems.

78:03F-091
IA SPRINKLER TEST STANDARDS,
Bruce, D.A.
Product Design & Systems Engineering, Ag-Turf Division, Johns-Manville Sales Corporation, Fresno, California.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 282-289, February 26-28, 1978. 2 tab.

Descriptors: Sprinkler irrigation, Testing procedures, Standards, Testing, Performance, Irrigation, Evaluation.

After many years of discussion, rejection and frustration, the irrigation industry is on the threshold of adopting a uniform method of testing sprinklers, collecting test data and reporting product performance. This paper outlives the sprinkler test procedure developed by a working committee formed by The Irrigation Association. The IA is attempting to issue a joint standard with the American Society of Agricultural Engineers.

78:03F-092
A NOTE ON THE ECONOMIC SIGNIFICANCE OF UNIFORM WATER APPLICATION,
Seginer, I.
Technion, Haifa, Israel, Department of Agricultural Engineering.
Irrigation Science, Vol. 1, No. 1, August, 1978, p 19-25. 3 fig, 7 ref, 23 equ.

Descriptors: Water distribution (applied), Crop production, Water costs, Optimization, Economics, Distribution patterns, Sprinkler irrigation, Yield equations.

It was shown how a yield vs water application diagram, with uniformity of water-distribution and price of water as parameters, can be used to determine the optimum water application and the expected income for a certain crop. The diagram can further be used to explore the possible outcome of changing water uniformity and/or price. The diagram was based on simplified forms of the yield and water-distribution functions.

78:03F-093
ANALYSIS OF TRICKLE IRRIGATION WITH APPLICATION TO DESIGN PROBLEMS,
Bresler, E.
Institute of Soils and Water, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel, Division of Soil Physics.
Irrigation Science, Vol. 1, No. 1, August, 1978, p 3-17. 6 fig, 1 tab, 18 ref, 19 equ.

Descriptors: Irrigation design, Water conservation, Design, Flow rates, Infiltration, Hydraulic conductivity, Unsaturated flow.

An existing numerical solution to nonsteady state infiltration was used to quantify the effect of soil hydraulic properties and trickle discharge rates on emitter spacing. The results of the analysis suggested the possibility of controlling the wetted volume of a soil by regulating the emitter discharge according to soil properties. The surface distribution of a transformed soil water content (or pressure) function was derived from a linearized solution to steady infiltration. The analysis of steady and nonsteady infiltration was employed to estimate the spacing between emitters as a function of discharge and water pressure conditions between emitters using hydraulic soil data. Hydraulic conductivity parameters were given for 17 different soils which were used for design purposes. Theoretical analysis of soil water was combined with hydraulic principles to derive lateral diameter and length for engineering design requirements.

78:03F-094
CENTER PIVOT IRRIGATION IN THE COLUMBIA BASIN OF WASHINGTON AND OREGON: DYNAMICS AND IMPLICATIONS,
Muckleston, K.W., and Highsmith, R.M.
Oregon State University, Corvallis, Department of Geography.
Water Resources Bulletin, Vol. 14, No. 5, p 1121-1128, October, 1978. 1 fig, 13 ref.
(See 78:06A-007)

78:03F-095
METHODOLOGY AND EMPIRICAL ESTIMATES OF THE RESPONSE FUNCTION OF SORGHUM TO IRRIGATION AND SOIL MOISTURE,
Bielorai, H., and Yaron, D.
Institute of Soils and Water, The Volcani Center, Bet-Dagan, Israel, Institute of Agricultural Research.
Water Resources Bulletin, Vol. 14, No. 4, p 966-977, August, 1978. 3 tab, 4 fig, 17 ref.

Descriptors: *Methodology, *Irrigation, *Soil moisture, *Sorghum, *Crop response, Estimating, Equations, Systems analysis, Response function, Critical days.

Presented is a methodology for the estimation of response functions of crops to irrigation and soil moisture. A systems analysis framework is applied to describe the relationships involved. Two subsystems are distinguished, with the first one involving the relationship between irrigation decision variables and soil state variables, and the second involving the relation between soil state variables and crop yield. A method for tracing and predicting soil moisture profile variations over time and depth is presented, and empirical estimates of the response function of grain sorghum to soil moisture are derived. In the specification of the response function the concept of "critical days" is applied with a "critical day" being defined as one where the soil moisture is depleted below a certain critical level. The paper provides empirical evidence for the usefulness of the approach.

78:03F-096
ECONOMIC AND AGRONOMIC EFFECTS OF HIGH IRRIGATION LEVELS ON ALFALFA AND BARLEY,
Delaney, R.H., Jacobs, J.J., Borrelli, J., Clark, R.T., and Hedstrom, W.E.
Wyoming University, Laramie, Water Resources Research Institute.
Water Resources Series No. 68, January, 1978, 78 p. 7 fig, 27 tab, 46 ref.

Descriptors: *Irrigation effects, *Agronomic crops, *Drainage, *Agricultural economics, *Irrigation practices, Income, Labor savings, Profit, Surface irrigation, Crop response, Irrigation efficiency, Leaching, Water injury, Alfalfa, Barley, Feed barley, Malt barley, Overirrigation, Excess water.

Five water levels were used on alfalfa, feed barley, and malt barley. Treatments 2, 4 and 5 were irrigated with quantities of water sufficient to bring the soil to field capacity (FC) from 50% of the available moisture (AM), twice this quantity and four times this quantity, respectively. Treatments 1 and 3 were irrigated to FC when 90 and 10% respectively, of the AM was depleted. The highest irrigation level on alfalfa yielded an average of 2 mt/ha/yr less than level 1 over the 3 year study and 1-1/2 mt/ha/yr less than level 2, which was the check treatment. The phosphorus content of the forage was reduced by the two driest irrigation levels and could require P supplementation when fed to some classes of livestock. The yield of feed barley for the highest irrigation level was reduced 18% when compared to the driest treatment. The average yield of malt barley for the 2 years was reduced 22% by irrigation level 5 compared to irrigation level 1. An economic analysis of the plot yield data showed that irrigation practice No. 1 provided the largest return to management and land. These results suggest that irrigators might be able to reduce the quantity of water used and increase yields as well. An analysis of the yield data for crops, both with and without irrigation scheduling (IS), showed that yields were generally higher when a crop was under IS. An economic analysis of the yield increase for alfalfa and barley indicated that the increased yield would more than pay for the cost of the IS service. For the given physical situation and irrigation practices similar to those used in water level 3, the drainage system would cost $86/ha/yr, for water level 4-$272/ha/yr, and for water level 5-$1038/ha/yr.

78:03F-097
PERFORMANCE OF CENTER-PIVOT SPRINKLER IRRIGATION SYSTEMS OPERATING AT REDUCED PRESSURES,
Ali, S.M.A., and Barefoot, A.D.
Oklahoma State University, Stillwater, Department of Agricultural Engineering.
Paper No. 78-2005, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 19 p. 4 fig, 4 tab, 14 ref.

Descriptors: Sprinkler irrigation, Irrigation systems, Performance, Water pressure, Low flow, Uniformity coefficient, Distribution patterns, Evaporation, Irrigation.

Spray distribution obtained from a single stationary sprinkler head was utilized to determine the effects of reduced operating pressure on evaporation loss, uniformity of application, sprinkler spacing, and application rate of a center-pivot sprinkler irrigation system. Results indicated that at reduced pressure, the sprinkler performances were satisfactory.

78:03F-098
"CORNER PIVOT" AN EFFECTIVE CORNER WATERING SYSTEM,
Callies, R.E.
Lindsay Manufacturing Company, Lindsay, Nebraska.
Paper No. 78-2006, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p.

Descriptors: Sprinkler irrigation, Irrigated land, Irrigation efficiency, Irrigation systems, Design, Performance, Distribution, Distribution systems, Irrigation.

The "Corner Pivot" system incorporates the use of a long span single tower center pivot irrigation machine which is attached to and pivots about the outer most tower of a conventional center pivot irrigation machine. This attachment is used to extend the reach of the standard machine for the purpose of watering the corners or irregularly shaped areas along the perimeter of the field which could not normally be reached by a conventional center pivot machine.

78:03F-099
MATHEMATICAL MODELS AND BORDER IRRIGATION DESIGN,
Fangmeier, D.D., and Strelkoff, T.
Arizona University, Tucson, Department of Soil, Water and Engineering.
Paper No. 78-2007, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 11 p. 11 fig, 4 tab, 6 ref, 19 equ.

Descriptors: Border irrigation, Irrigation design, Mathematical models, Evaluation, Runoff, Design criteria, Infiltration rates, Recession curves, Time lag, Irrigation efficiency.

A mathematical model of flow in irrigation borders assuming zero inertia was used to evaluate U.S. Soil Conservation Service design criteria for sloping borders with runoff and to demonstrate model capabilities. Model results indicated that the Soil Conservation Service design criteria are reasonable.

78:03F-100
BORDER-STRIP IRRIGATION DESIGN--PRACTICAL APPROACH FROM A THEORETICAL BASIS,
Merriam, J.L.
California Polytechnic State University, San Luis Obispo, Department of Agricultural Engineering.
Paper No. 78-2008, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 14 p. 14 fig, 1 tab, 2 ref, 3 equ.

Descriptors: Irrigation design, Border irrigation, Surface irrigation, Graphical methods, Recession curves, Flow rates, Irrigation efficiency, Moisture deficit, Time lag, Infiltration.

A graphical procedure was developed for designing border-strip irrigation systems. It is based on the principle that the shape of the recession curve is relatively unchanging for any specific field, and therefore, it is the controlling key condition for design or operation. Conditions modifiable by the designer or operator to obtain high efficiency are: (1) the stream size that controls the rate of advance; (2) the Management Allowed Deficiency of soil moisture at the time of irrigation; (3) the length of the strip; and (4) the distance down the strip at which flow is cut off.

78:03F-101
RAPIDLY OBTAINING OPTIMAL IRRIGATION SYSTEM DESIGNS,
Busch, J.R., Galinato, G.D., Brockway, C.E., and Steinbach, G.E.
Idaho University, Aberdeen.
Paper No. 78-2009, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 16 p. 6 fig, 8 ref.

Descriptors: Irrigation design, Irrigation systems, Irrigation, Optimization, Computer programs, Computer models, Cost allocation, Costs, Dynamic programming, Linear programming.

A methodology was developed and tested that will allow irrigation planners to obtain optimal system designs. Computer routines were used to obtain costs of individual system components. The optimization procedures produce least cost designs subject to specified constraints and these constraints can easily be changed to allow rapid evaluation of alternatives.

78:03F-102
COMPUTER MODEL FOR CENTER PIVOT SPRINKLER DESIGN,
Kelso, G.L., and Jarrett, A.R.
Pennsylvania State University, University Park, Department of Agricultural Engineering.
Paper No. 78-2003, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 19 p. 12 fig, 6 tab, 7 ref, 42 equ.

Descriptors: Sprinkler irrigation, Computer models, Computer programs, Irrigation systems, Flow rates, Uniformity coefficient, Irrigation design, Irrigation.

A computer aided center pivot design program was presented. The program selected specific sprinklers and nozzles from input parameters of flow rate to the pivot, system length, sprinkler spacing and desirability of an endgun. The program also computed a uniformity coefficient for the system based on the sprinklers and nozzles selected.

78:03F-103
THE USE OF COMPUTERS TO NOZZLE CENTER PIVOT SYSTEMS,
Morgan, R.M.
The Toro Company, Riverside, California 92504.
Paper No. 78-2002, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 8 p.

Descriptors: Sprinkler irrigation, Distribution patterns, Computer programs, Distribution, Nozzles, Irrigation systems, Water distribution (applied), Irrigation.

The practice of irrigation by sprinkler head distribution on center pivot machines has been a system of application crops for nearly twenty years. Many types of heads and spacings have been used with a goal toward achieving more even distribution. The art of computer-use to predetermine distribution uniformity was discussed.

78:03F-104
DETERMINING CENTER-PIVOT SPRINKLER UNIFORMITIES,
Ring, L., and Heermann, D.F.
Agriculture Center, Lethbridge, Alberta T1J 4C7, Alberta Agriculture.
Paper No. 78-2001, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p. 3 fig, 6 tab, 12 ref, 4 equ.

Descriptors: Sprinkler irrigation, Uniformity coefficient, Irrigation efficiency, Distribution, Distribution patterns, Irrigation design, Evaluation, Irrigation.

Catch can evaluations were conducted and the water application and uniformity were calculated for different can spacings and number of rows. Results were compared to each other and to a theoretical application pattern. A recommended procedure for the field evaluation of center-pivot systems was suggested.

78:03F-105
VARIABILITY OF SPRINKLER COEFFICIENT OF UNIFORMITY TEST RESULTS,
Solomon, K.
RainBird Technical Services, Logan, Utah.
Paper No. 78-2010, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 10 p. 2 fig, 2 tab, 4 ref.

Descriptors: Sprinkler irrigation, Uniformity coefficient, Irrigation efficiency, Statistical methods, Regression analysis, Variability.

Sprinkler coefficient of uniformity (UC) test results were analyzed and found to vary significantly, even under similar test conditions. The amount of anticipated variation in measured UC values was correlated with the UC value itself. Factors influencing this variation were discussed.

78:03F-106
REUSE PITS: CHEAPEST WATER ON THE FARM,
White, J.G.
Denver, Colorado.
Irrigation Age, Vol. 13, No. 3, p 58, 62, November-December, 1978. 2 fig.

Descriptors: Tailwater, Water conservation, Irrigation efficiency, Irrigation, Crop production, Irrigation practices, Nebraska, Agricultural runoff.

This article describes the benefits of using tailwater pits as experienced by farmers in Nebraska. It was found that the pumping cost was reduced by one-fourth compared with what it costs to pump from the deep wells, reduced the time and labor, and reduced the amount of deep-well water use by 20%. It was also estimated that the gravity irrigation efficiency was increased by almost 15%.

78:03F-107
A PROGRAM TO PROMOTE IRRIGATION CONSERVATION IN IDAHO,
Hammond, J.
State of Idaho, Statehouse, Boise, Department of Water Resources.
Pacific Northwest Regional Commission, March, 1978. 43 p, 6 fig, 12 ref.

Descriptors: Water conservation, Irrigation, Programs, Idaho, Water management (applied), Water law, Water costs, Social aspects, Legal aspects, Water delivery.

This study investigated the economic, social, legal and institutional factors affecting irrigation efficiency and sought incentives for promoting irrigation water conservation. This report presents the results of the study and outlines alternatives for formulating a comprehensive irrigation conservation program. Specifically, it discusses the promotion of irrigation water conservation, attitudes and incentives involved in such conservation, water conservation aspects of Idaho laws, and evaluates three alternative programs for pomoting irrigation water conservation.

78:03F-108
CONSERVATION AND CONVENTIONAL SYSTEMS FOR CONTINUOUS PRODUCTION OF CORN,
Erbach, D.C., Lovely, W.G., and Ayres, G.E.
Iowa State University, Ames, Department of Agricultural Engineering.
Paper No. 78-2517, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 9 p. 4 fig, 9 tab, 22 ref.

Descriptors: Till, Soil management, Conservation, Crop production, Corn (field), Economics, Weed control, Iowa.

Seven tillage systems were evaluated for continuous production of corn in Central Iowa on a soil from the Clarion-Nicollet-Webster Soil Association. Comparative week control, stand establishment, surface plant residue, soil nutrient profile, yield, and economic results were discussed.

78:03F-109
WATER BALANCE IN IRRIGATED SOILS,
Botzan, M., and Merculiev, O.
Academy of Agriculture and Forest Sciences, Bucharest, Romania.
ICID Bulletin, Vol. 27, No. 2, p 23-29, 35, July, 1978. 26 ref.

Descriptors: Water balance, Irrigation design, Irrigation programs, Consumptive use, Soil-water-plant relationships, Leaching, Evapotranspiration, Irrigation.

The paper presented the results obtained by land experimental research works carried out in different pedoclimatic zones of Romania (temperate zone) between 1945-1947 and continuously since 1951. The water balance elements (initial reserve, final reserve, winter and summer precipitations, groundwater supply, soil water consumption on different calculated probabilities on crops and pedoclimatic zones, the water application and the irrigation rates during the vegetation and supply periods) were quantitatively characterized. Interrelationships of water consumption with the type of crop and pedoclimatic zone, soil humidity, air temperature, and crop yield were established. These correlations allowed for establishing an indirect water-consumption calculation method. For the irrigation project designing model, the basic elements and the limitative conditions were established. Both the irrigation as required and irrigation by rotation were analyzed for the water application forecast and programming. Also, the basic participating elements of the model in the prognosis stage were established together with the limitative conditions which determine the water application program in the row for plots irrigated in a single rotation.

78:03F-110
LATERALLY CONFINED FLOW FROM A POINT SOURCE AT THE SURFACE OF AN INHOMOGENEOUS SOIL COLUMN,
Merrill, S.D., Raats, P.A.C., and Dirksen, C.
Northern Great Plains Research Center, P.O. Box 459, Mandan, North Dakota 58554.
Soil Science Society of America Journal, Vol. 42, No. 6, p 851-857, November-December, 1978. 8 fig, 18 ref, 22 equ.

Descriptors: Confined water, Steady flow, Infiltration, Irrigation, Hydraulic conductivity, Irrigation design, Distribution, Pressure head, Water conservation.

Solution of a linearized flow equation for steady, axisymmetric, laterally confined infiltration from a point source located at the soil surface was compared with pressure head patterns measured in an undisturbed column of sandy loam. The geometry approximated an array of trickle irrigation emitters. The hydraulic conductivity could be represented as an exponential function of both the pressure head and the depth in the column. This implied that steady, multidimensional flow in the column could be described by a linear flow equation. Measured and predicted distributions of pressure head agreed most closely at an application rate of 0.5 cm/day. Increase in the size of a saturated zone about the point source at application rates higher than 0.5 cm/day caused isolines of pressure head to be distorted from the predicted shape. Flow patterns for homogeneous and heterogeneous soil were compared. Measured distributions of pressure heads under intermittent trickle application were compared with steady infiltration patterns. It was concluded that a steady-flow solution will give an approximate prediction of intermittent pressure head patterns for continuously repeated application cycles over part of the flow region and during part of the time.

78:03F-111
WATER BALANCE OF FLOODED RICE PADDIES,
Brown, K.W., Turner, F.T., Thomas, J.C., Deuel, L.E., and Keener, M.E.

Texas A & M University, College Station, Department of Soil and Crop Sciences.
Agricultural Water Management, Vol. 1, No. 3, p 277-291, November, 1978. 10 fig, 3 tab, 8 ref.
(See 78:02I-037)

78:03F-112
REMOTE SENSING FOR AGRICULTURAL WATER MANAGEMENT AND CROP YIELD PREDICTION,
Idso, S.B., Jackson, R.D., and Reginato, R.J.
United States Water Conservation Laboratory, Phoenix, Arizona.
Agricultural Water Management, Vol. 1, No. 4, p 299-310, December, 1978. 5 fig, 32 ref, 5 equ.

Descriptors: Remote sensing, Water management (applied), Crop production, Scheduling, Irrigation, Albedo, Soil moisture, Evaporation, Reviews.

This paper reviewed the research conducted at the U.S. Water Conservation Laboratory, Phoenix, Arizona over the past several years relative to agricultural application of remote sensing. In addition, new data were presented. The subjects treated were soil moisture, evaporation, irrigation scheduling, and crop yield estimation. The analyses indicated that we have the technology at hand to successfully integrate remote sensing techniques into agricultural operations designed to enhance production via intelligent water management.

78:03F-113
BEST USE OF CROP RESIDUES,
Fenster, C.R., Follett, R.H., and Williamson, E.J.
Nebraska University, Lincoln, Department of Agronomy.
Crops and Soils Magazine, Vol. 30, No. 9, p 10-13, August-September, 1978. 3 fig, 2 tab.

Descriptors: Feeds, Crops, Organic matter, Soil erosion, Energy.

This paper looks at the present and some potential uses of crop residues. It concluded that the best use of crop residues depends on the crop, the soil, the location of the place where the particular crop and soil exist, and a number of other problems directly and remotely related to agriculture.

78:03F-114
CHEMICAL INJECTION POPULAR IN NORTHWEST,
Henry, C.
Irrigation Age, Northwest/Pacific Editor.
Irrigation Age, Vol. 13, No. 3, p 46-47, November-December, 1978. 3 fig.

Descriptors: Irrigation, Fertilizers, Fertilization, Chemicals, Sprinkler irrigation, Application methods, Application equipment, Injection.

This article reports and discusses the methods and benefits of applying liquid chemicals and fertilizers with irrigation water.

78:03F-115
ELECTRONIC TIMERS FOR AUTOMATED SURFACE IRRIGATION SYSTEMS,
Fisher, H.D., Humpherys, A.S., and Worstell, R.V.
Snake River Conservation Research Center, Kimberly, Idaho, United States Department of Agriculture.
Paper No. 78-2544, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 7 p. 3 fig, 5 ref.

Descriptors: Surface irrigation, Automatic control, Control systems, Automation, Timing, Electronic equipment, Instrumentation, Furrow irrigation, Irrigation systems.

Electronic timers were developed to replace alarm clocks and mechanical timers for semiautomated irrigation structures and valves. Timer-controllers including a micro-processor unit were designed for a field tested with automatic cutback, buried lateral and multiset furrow irrigation systems.

78:03F-116
VOLUMETRIC CONTROL FOR IRRIGATION AUTOMATION,
Duke, H.R., Payne, M.L., and Kincaid, D.C.
Agricultural Research, Science and Education Administration, United States Department of Agriculture.
Paper No. 78-2545, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 8 p. 3 fig, 4 ref.

Descriptors: Surface irrigation, Automatic control, Control systems, Automation, Electronic equipment, Instrumentation, Irrigation programs, Irrigation systems.

A digital electronic controller was developed for use in surface irrigation automation. This controller has full random-multiplexing capabilities and is capable of integrating flow rates as measured through a nonlinear open channel flow measurement device.

78:03F-117
UTILIZATION OF A PORTABLE SOLID STATE FURROW IRRIGATION VALVE CONTROLLER,
Edling, R.J., Duke, H.R., and Payne, M.L.
Nebraska University, Scottsbluff.
Paper No. 78-2546, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 3 fig, 4 ref.

Descriptors: Furrow irrigation, Valves, Control systems, Automation, Instrumentation, Application equipment, Electronic equipment, Irrigation systems.

Research was conducted during the summers of 1977-1978 on an USDA-SEA controller to allow semi-automatic changing of furrow irrigation sets. Two types of control valves were used with the controller. After initial difficulties, satisfactory use was obtained with the controller and both types of valves. Additional work in an on-farm situation was advised before the controllers use is recommended.

78:03F-118
DIGITAL CONTROLLER FOR TRICKLE IRRIGATION,
Fangmeier, D.D., and Busman, J.D.
Arizona University, Tucson, Department of Soils, Water and Engineering.
Paper No. 78-2547, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 7 p. 5 fig, 1 tab, 5 ref.

Descriptors: Control systems, Irrigation systems, Water conservation, Electronic equipment, Evaporation, Soil moisture, Moisture tension, Timing, Consumptive use, Application equipment.

A digital controller was designed using complementary metal oxide semiconductor electronics. The controller uses measured evaporation pan depths and soil moisture tensions to determine the time required to apply the desired quantity of water on a daily basis. Circuit diagrams for major components were presented.

78:03F-119
RESPONSE OF CORN TO LIMITED IRRIGATION ON SANDY SOILS,
Wilson, G.D., Watts, D.G., and Fischbach, P.E.
Nebraska University, North Platte, Department of Agricultural Engineering.
Paper No. 78-2554, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 11 p. 6 fig, 5 tab, 3 ref, 1 equ, 3 append.
(See 78:02I-040)

78:03F-120
EVALUATION OF CROP WATER STRESS UNDER LIMITED IRRIGATION,
Heermann, D., and Duke, H.
Agricultural Research, Science and Education Administration, Fort Collins, Colorado, United States Department of Agriculture.
Paper No. 78-2556, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 5 p. 8 fig, 8 ref.
(See 78:02I-041)

78:03F-121
IRRIGATED CORN YIELD RESPONSE TO WATER,
Musick, J.T., and Dusek, D.A.
Southwestern Great Plains Research Center, Bushland, Texas, United States Department of Agriculture.
Paper No. 78-2557, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 26 p. 8 fig, 3 tab, 16 ref.
(See 78:02I-042)

78:03F-122
CORN YIELD RESPONSES TO WATER STRESS MANAGEMENT,
Stegman, E.C., and Aflatouni, M.
North Dakota State University, Fargo, Department of Agricultural Engineering.
Paper No. 78-2558, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 9 p. 8 fig, 3 tab, 18 ref, 1 equ.
(See 78:02I-034)

78:03F-123
HARVESTING RUNOFF FROM PRECIPITATION ON IRRIGATED LANDS,
Manges, H.L., and Mao, L.-T.
Kansas Agricultural Experiment Station, Manhattan, Kansas.
Paper No. 78-2559, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 10 p. 2 fig, 3 tab, 10 ref, 11 equ.

Descriptors: Water harvesting, Runoff, Precipitation (atmospheric), Tailwater, Climatic data, Model studies, Evapotranspiration, Water balance, Irrigation, Corn (field).

A tailwater management model was developed to simulate runoff from precipitation on irrigated land. The model was tested for corn using 25 years of climatological data for Garden City, Kansas. Runoff from precipitation repumped onto the field averaged 69 and 39 millimeters annually for two commonly irrigated soils.

78:03F-124
THE TIMELINESS BENEFIT OF SUBSURFACE DRAINAGE,
Wendte, L.W., Drablos, C.J.W., and Lembke, W.D.
Soil Conservation Service, Kankakee, Illinois.
Transactions of the American Society of Agricultural Engineering, Vol. 21, No. 3, p 484-488, May-June, 1978. 6 fig, 3 tab, 21 ref.

Descriptors: *Subsurface drainage, *Agriculture, *Benefits, *Model studies, Mathematical models, Planting management, Farm management, Drains, Tile drains, Economics.

A simulation model was developed to predict available spring workdays and the earliest possible planting dates for soils with a subsurface drainage system. Applying the model to two Illinois soils, it was found that as many as two available workdays in April and 19 days in May are gained by installing a recommended subsurface drainage system. The optimum drain spacing based on the timeliness benefit of earlier corn planting ranged from 24 to 61 m, depending on permeability and soil type. The average annual timeliness benefit for installing the optimum subsurface drainage system was $37 to $156/ha.

78:03F-125
WATER TABLE DEPTH AND IRRIGATION EFFECTS ON WATER USE EFFICIENCIES OF THREE CROPS,
Benz, L.C., Reichman, G.A., Doering, E.J., and Follett, R.F.
Agricultural Research Service, Northern Great Plains Research Center, Mandan, North Dakota.
Paper No. 77-2039 presented at the 1977 Annual Meeting of the American Society of Agricultural Engineers, June 26-29, 1977, Raleigh, North Carolina, 17 p. 7 fig, 3 tab, 14 ref.

Descriptors: *Corn (field), *Sugarbeets, *Water table, *Irrigation effects, *Alfalfa, Irrigation, Irrigation efficiency, Irrigation practices.

Production and applied water-use efficiencies (AWUE) of corn, sugarbeets, and alfalfa from a 3-year field experiment at three water table depths and four irrigation rates were highest from the shallow water table treatment without irrigation.

78:03F-126
ESTIMATING SPRINKLER DISTRIBUTION PATTERNS USING LINEAR REGRESSION,
Karmeli, D.
Colorado State University, Fort Collins, Department of Agricultural and Chemical Engineering.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 4, p 682-686, August 20, 1978. 5 fig, 2 tab, 5 ref, 9 equ.

Descriptors: Sprinkler irrigation, Distribution patterns, Estimating equations, Regression analysis, Spatial distribution.

The linear regression was used to describe sprinkler distribution patterns. The linear fit was found to approximate the distribution very well in a wide range. This approximation proved to produce good estimates for both high and low quality distributions. In the higher quality distributions, the linear regressions model estimated the actual field data as well as the normal model. However, in lower quality distributions the linear regression model proved significantly better than the normal model in its estimates. A new coefficient, UCL, was suggested for practical use.

78:03F-127
TRICKLE IRRIGATION UNIFORMITY AND EFFICIENCY,
Solomon, K., and Keller, J.
Rain Bird Technical Services, Glendora, California.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR3, p 293-306, September, 1978. 5 fig, 1 tab, 8 ref, 16 equ.

Descriptors: Irrigation efficiency, Irrigation practices, Water conservation, Uniformity coefficient, Water pressure, Water distribution (applied), Pressure head, Design criteria.

Expressions were developed for the pressure head in a trickle irrigation lateral and throughout the pipe network for three common types of manifolds. Histograms were drawn showing the distributions of pressure in typical trickle irrigation systems. The distributions were skewed toward the low head end, and the degree of skew depended on the type of manifold and the ratio of manifold head loss to lateral head loss. Flow rate histograms were drawn showing the combined effects on emitter discharge spread, manifold construction, head losses and variation in emitter manufacture. Coefficient of manufacturing variation was shown to be as important a design consideration as the amount of head loss in the system. Values of emission uniformity and absolute emission uniformity were tabulated for various emitter and system configurations on level ground. It was pointed out that in many cases the results of this study can be applied to sloping terrain as well.

78:03F-128
AUTOMATION OF ON-FARM IRRIGATION TURNOUTS UTILIZING JACK-GATES,
Dedrick, A.R., and Erie, L.J.
United States Water Conservation Laboratory, Phoenix, Arizona.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 1, p 92-96, February 20, 1978. 6 fig, 3 tab, 7 ref.

Descriptors: Irrigation, Surface irrigation, Automation, Automatic control, Turnouts.

The design, development, and installation of equipment used to automate existing single outlet turnouts (jack-gates) on a 26.3-ha (65-acre) field were described. Specific jack-gate modifications and equipment requirements; control center design associated with safety overflow, excess water after irrigation, and sequencing functions; and system operations were all discussed.

78:03F-129
THE ROLE OF EVAPOTRANSPIRATION MODELS IN IRRIGATION SCHEDULING,
Jensen, M.E., and Wright, J.L.
Snake River Conservation Research Center, United States Department of Agriculture-Agricultural Research Service, Kimberly, Idaho.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 1, p 82-87, February 20, 1978. 4 fig, 2 tab, 25 ref, 3 equ.
(See 78:02D-007)

78:03F-130
AUTOMATION OF AN OPEN-DITCH IRRIGATION CONVEYANCE SYSTEM UTILIZING TILE OUTLETS,
Erie, L.J., and Dedrick, A.R.
United States Water Conservation Laboratory, Phoenix, Arizona.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 1 p 119-123, February 20, 1978. 6 fig, 6 ref.

Descriptors: Irrigation ditches, Automation, Automatic control, Tiles, Irrigation, Conveyance structures.

Nearly 80% of the irrigated lands in the United States use surface irrigation techniques. Most of the on-farm, irrigation-water distribution systems are of the open-ditch type. The latest trend in western Arizona and parts of California is to dead-level fields, then irrigate from single or multiple outlets with large streams of water. These level basins are well adapted to automation. An automated irrigation system reduces farm labor requirements and, as an irrigation management tool, can reduce water application, improve crop production, and minimize scalding and thus stand loss. A 28.4-ha (70-acre) field irrigated with tile outlets was pneumatically automated using two types of pillows on the outlet side, in combination with automated jack-gates, from a centrally located concrete-lined canal. The present system is being used by the farmer, observed and amended by the researchers, and demonstrated to many U.S. and foreign visitors.

SECTION XVI

WATER QUANTITY MANAGEMENT AND CONTROL

CONTROL OF WATER ON THE SURFACE (GROUP 04A)

78:04A-001
A STOCHASTIC MODEL OF THE OPERATION OF A STREAM-AQUIFER SYSTEM,
Flores, E.Z., Gutjahr, A.L., and Gelhar, L.W.
New Mexico Institute of Mining and Technology, Socorro.
Water Resources Research, Vol. 14, No. 1, p 30-38, February, 1978. 3 fig, 1 tab, 34 ref.

Descriptors: *Reservoir operation, *Stochastic processes, *Linear programming, *Water management (applied), *Optimization, Aquifers, Streams, Decision making, Effects, Wells.

A simple lumped parameter stochastic model for optimal water management in a stream-connected aquifer system is examined. The physical system is represented by a linear reservoir model, and a conditional probability approach is used to estimate the effect of parameter variability. A drawdown correction is used to incorporate the local drawdown of the wells and is a crucial part of the model. A management analysis is accomplished by using a linear decision rule to minimize the expected value of the discounted costs with appropriate chance constraints, and the resulting nonlinear optimization problem is solved iteratively using a standard linear programming package. In order to evaluate the limitations of the lumped parameter model in a management context, the results of the management technique are compared with results from Maddock (1974) who used a distributed representation of the aquifer. The conclusions of this analysis indicate that stochastic effects are not very important in arriving at an operating policy but are important in determining the expected cost.

78:04A-002
A VARIATIONAL INEQUALITY METHOD APPLIED TO FREE SURFACE SEEPAGE FROM A TRIANGULAR DITCH,
Bruch, J.C., Jr., and Sloss, J.M.
California University, Santa Barbara, Department of Mechanical and Environmental Engineering.
Water Resources Research, Vol. 14, No. 1, p 119-124, February, 1978. 2 fig, 2 tab, 12 ref.

Descriptors: *Mathematical models, *Seepage, *Ditches, Drains, Equations, Groundwater movement, Numerical analysis, Free surfaces, Soils, Depth.

Two-dimensional seepage from a single triangular channel into permeable soil underlain at a finite depth by a drain was solved by reducing the problem to a variational inequality. The results obtained consist of the location of the free surface, and thus, the shape of the seepage region, the velocity potential and stream function at a series of mesh points, and the seepage flow rate. The successive overrelaxation method with projection was used to solve the numerical problem. The numerical results compared very favorably with the analytical solution to the same problem.

78:04A-003
INTERTEMPORAL ALLOCATION OF IRRIGATION WATER IN THE MAYURAKSHI PROJECT (INDIA), AN APPLICATION OF CHANCE-CONSTRAINED LINEAR PROGRAMMING,
Maji, C.C., and Heady, E.O.
Indian Agricultural Research Institute, New Delhi, Water Technology Centre.
Water Resources Research, Vol. 14, No. 2, p 190-196, April, 1978. 10 tab, 29 equ, 14 ref.

Descriptors: *Irrigation water, *Water allocation (applied), *Linear programming, *Reservoir operation, *Cropping pattern, *Chance-constrained models, Projects, Water policy, Optimization, Economic efficiency.

Developed is an optimal cropping pattern and a reservoir management policy for the Mayurakshi irrigation project in India. Two chance-constrained linear programming models are formulated to account for the stochastic nature of the monthly inflows. The models also consider the increased economic opportunity offered by the introduction of new high-yielding crop varieties. The results clearly indicate that a change in the existing cropping pattern and reservoir management policy is desirable and is consistent with the maximization of net return to the project area. The existing supply of nitrogen fertilizer in the command area is found to be inadequate to allow for the best use of other resources, including irrigation water. As the probability of occurrence of a drought or a flood is kept within a limit of 10%, the crop activities in the optimal cropping pattern suffer from drought or flood conditions no more than 10% of the time. Thus the resulting cropping patterns should be preferred by the tradition-bound farmers of the command area, who have a low risk-bearing ability.

78:04A-004
SEQUENTIAL EXPLICITLY STOCHASTIC LINEAR PROGRAMMING MODELS: A PROPOSED METHOD FOR DESIGN AND MANAGEMENT OF MULTIPURPOSE RESERVOIR SYSTEMS,
Houck, M.H., and Cohon, J.L.
Purdue University, Lafayette, Indiana, School of Civil Engineering.
Water Resources Research, Vol. 14, No. 2, p 161-169, April, 1978. 12 ref.

Descriptors: *Multiple-purpose reservoirs, *Reservoir design, *Reservoir operation, *Linear programming, *Stochastic processes, *Nonlinear programming, *Economic efficiency, Optimization, Water management (applied), Operating rules.

A sequential explicitly stochastic linear programming model (SESLP) which consists of a nonlinear program and an algorithm for obtaining an approximate solution is presented. The SESLP model can be used to determine for a multipurpose multiple-reservoir system either both a design and a management policy or only a management policy. A discrete lag-one Markov process is explicitly included in the model as the streamflow description. The approximate solution to the nonlinear program is obtained by sequentially solving two linear programs which are subsets of the nonlinear program. A method of significantly reducing the computational burden and data requirements of the SESLP model is also presented. The method (system coordinated performance-individual operation (Scorpio)) is effective because within the SESLP/Scorpio model, although the operating rules for each reservoir are dependent on events occurring only at that reservoir site, system-wide performance levels are measured and the operation of each reservoir is coordinated with all other reservoirs. Problem objectives include food loss minimization and benefit maximization.

78:04A-005
EFFECT OF DRAIN TUBE OPENINGS ON WATER-TABLE DRAWDOWNS,
Skaggs, R.W.
North Carolina State University at Raleigh, Department of Biological and Agricultural Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No 1R1, Proceedings Paper 13606, p 13-21, March, 1978. 5 fig, 2 tab, 13 ref, 1 append.

Descriptors: *Tile drainage, *Drawdown, *Model studies, Mathematical models, Drains, Tile drains, Groundwater, Soil water, Soil water movement, Filters.

Conventional methods assume that the drain tube is completely open and offers no resistance to the entry of water. An approximate method of determining the effect of drain tube openings on water table drawdown was presented, based on the use of Hooghoudt's equivalent depth to account for convergence near the drain during water table drawdown. Data from the literature were used to define an effective drain tube radius, r sub e, for drains with a finite number of openings. The r sub e value was used then to define the Hooghoudt equivalent depth which was, in turn, used in solutions to the Boussinesq equation for water table drawdown. The use of an envelope wrap material will permit a somewhat wider drain spacing for all cases with a large increase in spacing for the deeper profile. The allowable increase in spacing for both cases was relatively small, and the total system cost with the envelope wrap was about 6% higher than without the wrap for the shallow profile and about 7% lower for the deep profile.

78:04A-006
HYDROLOGIC IMPACT OF GRAZING ON INFILTRATION: A CRITICAL REVIEW,
Gifford, G.F., and Hawkins, R.H.
Utah State University, Logan, College of Natural Resources, Watershed Science Unit.
Water Resources Research, Vol. 14, No. 2, p 305-313, April, 1978. 5 fig, 4 tab, 37 ref.

Descriptors: Grazing, Infiltration, Infiltration rates, Hydrologic aspects, Reviews, Ranges, Runoff, Hydrographs, Water yield.

The hydrologic importance of grazing is receiving increased attention on rangelands in the United States. The literature on this topic is fragmented. This paper explores the available literature for information useful in understanding the hydrologic impacts of grazing intensity as related primarily to infiltration and runoff. Generally, data relative to range condition are not adequate for evaluating hydrologic impacts. Data relating grazing intensity to infiltration rates are available, yet distinct limitations are evident. These limitations are discussed in terms of identifying future research needs. The greatest need appears to be a detailed definition of the long-term effects of grazing (by year and season) on infiltration rates as a function of site, range condition, and grazing intensity. Once obtained, infiltration rates must be coupled with an appropriate method for generating runoff volumes, storm hydrographs, and long-term water yields.

78:04A-007
A KINEMATIC MODEL FOR SURFACE IRRIGATION,
Sherman, B., and Singh, V.P.
New Mexico Institute of Mining and Technology, Socorro, New Mexico 87801.
Water Resources Research, Vol. 14, No. 2, p 357-364, April, 1978. 10 fig, 41 ref, 46 equ.

Descriptors: Surface irrigation, Mathematical models, Analytical techniques, Infiltration, Hydrodynamics, Momentum equation.

A kinematic wave model is developed to study surface irrigation. Depending on the variability of infiltration and the kinematic wave friction parameter, three cases are distinguished. Explicit analytical solutions are obtained for the case when infiltration is constant, and a possible approach is suggested for the case when it is not.

78:04A-008
RESERVOIR STORAGE WITH DEPENDENT, PERIODIC NET INPUTS,
Troutman, B.M.
Geological Survey, Denver, Colorado, Water Resources Division.
Water Resources Research, Vol. 14, No. 3, p 395-401, June, 1978. 5 fig, 20 ref.

Descriptors: *Reservoirs, *Reservoir storage, *Storage capacity, *Projections, *Stochastic processes, Inflow, Water demand, Time series analysis, Seasonal, Storms.

Two random quantities, the range and the maximum deficit, which may provide a measure of the required storage capacity of a reservoir over a fixed length of time, are considered. Interest in the range from an engineering point of view was initiated by Hurst (1951), who demonstrated that for certain geophysical time series, sample values of the range exhibit a property that has subsequently become known as the "Hurst phenomenon". This property is discussed briefly, primarily with the intention of showing that the Hurst phenomenon can be interpreted so as to be consistent with the asymptotic results on the range. The second quantity, the maximum deficit, is simply the storage obtained when one applied the sequent peak algorithm. Of primary concern is the manner in which the statistical behavoir of these quantities is affected by dependence and periodicity in the net inputs to the reservoir. Dependence, sometimes referred to as persistence or serial correlation, is seen, for example, in the fact that a large stream discharge on a given day will tend to be followed by a large discharge on the next day. The periodicities are due primarily to seasonal variations in factors such as precipitation and demand for stored water.

78:04A-009
FLAT CHANNEL TERRACES FOR POLLUTION ABATEMENT AND SEDIMENT CONTROL,
Buchta, H.G., Liesemeyer, W.W., and Jackson, L.G.
United States Department of Agriculture, Soil Conservation Service, Grand Island, Nebraska.
Paper No. 78-2521, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 5 p. 1 fig, 4 ref.

Descriptors: Terracing, Pollution abatement, Sediment control, Runoff, Crop production, Semiarid climates, Computer programs, Diversion, Gullies, Nebraska.

Flat channel terraces have been effectively used to control and use runoff water. The runoff can help stabilize crop production in a simiarid climate. Parallel flat channel terraces are growing in popularity.

78:04A-010
PARALLEL TERRACES ON FLAT SLOPES,
Fryrear, D.W., and Archer, E.
United States Department of Agriculture, Big Spring, Texas.
Paper No. 78-2522, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 15 p. 2 fig, 1 tab, 8 ref.

Descriptors: Terracing, Slopes, Slope stabilization, Soil conservation, Water conservation, Crop production, Dryfarming, Texas, Runoff, Economic justification.

West Texas has more terraces constructed each year then most states. This manuscript describes the design, layout, and construction of parallel terracing systems in this part of the state. Several farmers were interviewed concerning their feelings about parallel terraces and why they are used on their farms. The farmers are enthusiastic with the benefits of terraces particularly if they are involved in the design and construction of the system. Despite the point rows, more skilled operators, and increased time in the field, some producers feel that the increased production from terraced fields will pay for the construction costs in four to five years.

78:04A-011
DESIGN AND OPERATION OF GRADIENT TERRACE SYSTEMS,
Bondurant, D.T., and Laflen, J.M.
Soil Conservation Service, Des Moines, Iowa.
Paper No. 78-2520, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 7 p. 4 fig, 5 tab, 19 ref.
(See 78:02J-006)

78:04A-012
LAND USE EFFECTS ON CLAYPAN SOIL HYDROLOGY,
Kramer, L.A., and Burwell, R.E.
Science and Education Administration, Federal Research, Columbia, Missouri, United States Department of Agriculture.
Paper No. 78-2070, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 14 p. 7 tab, 5 ref.

Descriptors: Land use, Water yield, Land management, Clays, Runoff, Surface runoff, Corn (field), Wheat, Fallowing, Pastures.

Water yield data from 0.02-acre research plots for a ten-year study period of constant land use treatments are presented. The SCS Curve Number Procedure for runoff prediction gave ten-year average annual runoff values very similar to the observed land cover of fallow, continuous corn, small grain, and rotation meadow.

78:04A-013
CONTROLLING IRRIGATION RUNOFF LOSSES WITH PROPER MANAGEMENT,
Fitzsimmons, D.W., Busch, J.R., Lewis, G.C., and Berg, C.W.
Idaho University, Moscow, Department of Agricultural Engineering.
Paper No. 78-2090, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 14 p. 1 fig, 9 tab, 8 ref.

Descriptors: Surface runoff, Runoff, Tailwater, Erosion, Water management (applied), Pollutants, Surface irrigation, Water loss, Sediment control, Nutrient removal.

Field investigations to determine the effectiveness of irrigation, tillage and other practices in controlling surface runoff and resulting pollutant losses from surface-irrigated fields were conducted during two irrigation seasons. The results indicate that water, sediment and nutrient losses can be reduced or eliminated by the use of proper management practices.

78:04A-014
CHEMICAL CHARACTERIZATION OF THE GASEOUS AND LIQUID ENVIRONMENTS OF SUBSURFACE DRAIN SYSTEMS,
Meek, B.D., Grass, L.B., and MacKenzie, A.J.
Imperial Valley Conservation Research Center, Brawley, California.
Soil Science Society of America Journal, Vol. 42, No. 5, p 693-698, September-October, 1978. 3 fig, 6 tab, 14 ref.
(See 78:02K-052)

78:04A-015
EFFECTS OF DRAINAGE PROJECTS ON RUNOFF FROM DEPRESSIONAL WATERSHEDS,
Moore, I.D., and Larson, C.L.
Minnesota University, St. Paul, Department of Agricultural Engineering.
Paper No. 78-2504, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 5 p.

Descriptors: Drainage effects, Drainage practices, Surface drainage, Subsurface drainage, Surface runoff, Subsurface runoff, Peak discharge, Small watersheds, Mathematical models, Statistical methods.

Runoff from watersheds characterized by numerous depressions was studied statistically and by use of a special purpose watershed model. Application of the model to two small watersheds indicated that drainage development increases annual runoff, storm runoff and peak discharges.

78:04A-016
LEACHING CONTROL CAN'T BE PERFECT,
Larsen, R.
Irrigation Age, Associate Editor.
Irrigation Age, Vol. 13, No. 2, p 49, October, 1978. 1 fig.

Descriptors: Leaching, Leachate, Nitrogen, Nitrates, Irrigation, Scheduling, Water pollution, Nebraska.

This article reported the study to minimize losses from leaching conducted on sandy soils by some members of the Agricultural Engineering Department, University of Nebraska-Lincoln. The major conclusion of the study was that scheduling of irrigations to minimize percolation and proper selection of nitrogen (N) amount and source can have a significant effect on nitrate leaching loss when corn is produced on sandy soils. The study, however, indicated that reducing the loss to zero is not a practical goal on sandy soils.

78:04A-017
INFLUENCE OF ROW SPACING OF GRAIN SORGHUM ON GROUND COVER, RUNOFF, AND EROSION,
Adams, J.E., Richardson, C.W., and Burnett, E.
Grassland, Soil and Water Research Laboratory, P.O. Box 748, Temple, Texas 76501.
Soil Science Society of America Journal, Vol. 42, No. 6, p 959-962, November-December, 1978. 4 fig, 2 tab, 9 ref.

Descriptors: Runoff, Surface runoff, Erosion, Soil erosion, Canopy, Rainfall, Rainfall intensity, Grain sorghum, Cover crops.

A study was begun at Temple, Texas, in 1972 to assess the effect of narrow (50-cm) and conventional (100-cm) row spacing of grain sorghum on runoff and erosion from field-sized areas. Sorghum in narrow rows established a more complete plant canopy earlier than sorghum with conventional row spacing and provided more ground cover for much of the growing season. In 1973, runoff was 45% less and soil loss was 39% less from narrow-row grain sorghum than from sorghum with conventional row spacing. Narrow-row spacing of sorghum increased ground cover significantly (5% level) 35 days after emergence in 1974. Canopy cover was at maximum by 63 days after seeding emergence and provided a ground cover of 46 and 81% for sorghum with 100- and 50-cm row spacing, respectively.

78:04A-018
SEEPAGE CONTROL BY PARTICLE SIZE SELECTION,
Hauser, V.L.
Science and Education Administration, Temple, Texas, Grassland-Forage Research Center.
Transactions of the American Society of Agricultural Engineers, Vol. 21, No. 4, p 691-695, July-August, 1978. 9 fig, 1 tab, 12 ref.

Descriptors: *Linings, *Clays, *Gravels, *Aggregates, *Seepage control, Canal linings, Reservoirs, Canals, Hydraulic conductivity, Permeability, Soils, Sands, Seepage.

Earth linings are used frequently in reservoirs, canals, and other earth structures to control liquid movement for the purposes of pollution control, water conservation, and structural stability. Clays or chemicals often are added to linings to reduce the hydraulic conductivity of the native soil; however, both additives sometimes decrease in effectiveness with time. Under ordinary conditions, gravel is nearly inert and does not change properties with time. The hydraulic conductivity of permeable soil was reduced substantially by adding gravel that was at least 15 times larger than the particle size of the soil. The amount of clay required to control seepage was reduced by half by the addition of gravel.

SECTION XVII

WATER QUANTITY MANAGEMENT AND CONTROL

GROUNDWATER MANAGEMENT (GROUP 04B)

78:04B-001
WATER SUPPLY DILEMMAS OF GEOTHERMAL DEVELOPMENT IN THE IMPERIAL VALLEY OF CALIFORNIA,
Layton, D.W.
California University, Livermore, Lawrence Livermore Laboratory.
Water Resources Bulletin, Vol. 14, No. 1, p 133-143, February, 1978. 4 fig, 22 ref.

Descriptors: *Geothermal studies, *Thermal powerplants, *California, *Cooling water, *Water supply, *Imperial Valley (California), *Salton Sea (California), Water resources, Powerplants, Water requirements.

There are four known geothermal resource areas in the Imperial Valley that have a combined potential of over 4,000 megawatts of electrical energy for 25 years. Water resources available to support geothermal energy development are imported Colorado River water, agricultural waste waters, Salton Sea water, and groundwater. In addition, geothermal power plants can produce their own cooling water from steam condensate. Nevertheless, the relatively high water requirements of geothermal facilities along with a series of real and potential constraints may cause water supply dilemmas involving both the acquisition and use of cooling water. Important constraints are institutional policies, water supply costs, technical problems, and impacts upon the Salton Sea. These constraints and related dilemmas were examined in light of relevant information on the valley's water resources, geothermal resources and energy technologies, cooling water requirements, and water supply options.

78:04B-002
ARTIFICIAL GROUNDWATER RECHARGE WITH CAPILLARITY,
Ortiz, N.V., Duke, H.R., Sunada, D.K., and McWhorter, D.B.
Colorado State University, Fort Collins, Department of Civil Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. 1R1, Proceeding Paper 13627, March, 1978. 11 fig, 1 tab, 21 ref.

Descriptors: *Groundwater recharge, *Capillary action, *Artificial recharge, *Numerical analysis, *Model studies, *Capillary flow, *Capillary zone, *Groundwater mounds, Water table, Porous media.

The effect of capillarity on the transient response of the water table to recharge was evaluated by a numerical and a porous media model. The numerical model was developed to simulate the growth and spread of groundwater mounds, taking into consideration the flow and storage in the capillary regions. The contribution from the capillary region was described analytically in terms of recharge rates and the measureable soil properties of bubbling pressure, pore-size distribution index, and hydraulic conductivity. The numerical model was verified by comparing its predictions for various flow conditions with the result obtained from the porous media model. The effects of bubbling-pressure head, pore-size distribution index, initial saturated depth, depth to water table, and recharge rate on the predicted mound height were determined. It was shown that the effect of the capillary region significantly influences the growth and spread of groundwater mounds.

78:04B-003
DIURNAL PERIODICITY IN GROUNDWATER RECHARGE RATES,
Webb, S.N., and Watson, K.K.

New South Wales University, Kensington, Australia, School of Civil Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, Proceedings Paper 13613, March, 1978. 2 fig, 1 tab, 11 ref.

Descriptors: *Groundwater recharge, *Groundwater, *Algae, *Permeability, *Pore pressure, *Diurnal, *Australia, Frequency, Pore water, Pit recharge.

In an investigation of the flow characteristics of a recharge pit used for artificial groundwater recharge purposes, diurnal variations of a cyclic nature were detected in the intake rate. The output from soil water pressure sensors installed between the base of the pit and the water table indicated similar cyclic variations. The maximum intake rate occurred regularly each day at approximately 2 a.m. - 3 a.m. and the minimum approximately 12 hours later. It was concluded that these variations are due to the activity of algae on the base of the pit and in the top layer of sand. Diurnal peaks and troughs of the algae oxygen production result in changes in the hydraulic conductivity of the profile. This would appear to be related to changes in the volume of the occluded oxygen which exists as bubbles in the soil pores. These reduce the flow area available for recharge and thus cause a reduction in the intake rate.

78:04B-004
MANAGEMENT ASPECTS OF CYCLIC STORAGE OF WATER IN AQUIFER SYSTEMS,
Greydanus, H.W.
State of California, Resources Agency, Department of Water Resources, Box 388, Sacramento 95802.
Water Resources Bulletin, Vol. 14, No. 2, p 477-480, April, 1978.

Descriptors: Aquifer systems, Groundwater basins, Water storage, Water management (applied), California, Legal aspects, Water quality, Water rights, Water law, Environmental effects.

Most of California's precipitation falls at the wrong place in the wrong season in relation to the water needs. Redistribution and regulation are essential. Aquifer systems - groundwater basins - can provide a share of the future cyclic storage regulation. There are some differences in management concepts in using a full basin in comparison with a partially dewatered basin. Legal, water quality, and physical impacts on aquifer systems, including subsidence, are concerns. Storage may be for the benefit of overlying water users or for distant areas. Extraction during dry periods or recharge methods will require careful planning. Existing rights and uses and equitable treatment of all parties must be assured. Financial compensation may be involved. Changes in methods of operation or degree of self-determination by affected water agencies will require committed watermanship to resolve. Legislation or amendments to organic acts may be needed but much can be accomplished within existing statutes. Environmental impacts which can be avoided by not using large surface storage sites are important. Energy for pumping will be a key consideration. About 40% of California is underlain by aquifer systems. This resource offers major potential in overcoming the maldistribution of natural water resources.

78:04B-005
SUBSURFACE DRAINAGE OF AN ALLUVIAL CLAY SOIL FOR SOYBEANS,
Carter, C.E., and Camp, C.R.
P.O. Drawer U, University Station, Baton Rouge, Louisiana 70893.
Paper No. 78-2040, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 6 p. 3 fig, 2 tab, 7 ref.

Descriptors: Subsurface drainage, Subsurface drains, Soybeans, Crop response, Crop production, Clays, Louisiana, Economic feasibility.

A subsurface drainage field experiment was conducted on a 4 ha site of an alluvial clay soil in Tensas Parish, Louisiana, during 1974-1977. Subsurface drains spaced 7.5 and 15 m apart did not effectively control the water table but the soil water regime near the drains was improved somewhat. Soybean yields were significantly increased by this improved drainage three of four years with drains spaced 7.5 m apart and two of four years with drains spaced 15 m apart.

78:04B-006

FIELD EVALUATIONS OF GROUNDWATER CONTROL BY TRENCH AND TRENCHLESS METHODS OF INSTALLED DRAINS--LOWER RIO GRANDE VALLEY OF TEXAS,

Vittetoe, G.C., and Garner, B.J.

Soil Conservation Service, Temple, Texas, United States Department of Agriculture.

Paper No. 78-2043, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Utah, 6 p. 7 fig.

Descriptors: Subsurface drainage, Subsurface drains, Drainage practices, Trenches, Installation, Salinity, Flow rates, Groundwater, Water quality control, Texas.

This paper presents the result of field evaluations of the flow performance of 209 subsurface drainage systems in the Lower Rio Grande Valley of Texas. These drain systems are installed to control groundwater and serve as artificial subsurface drainage arteries for salinity management in an irrigated area. Of the 209 examined installations, 141 were installed by the trench method and 68 by the trenchless method. All systems were installed in calendar years 1975 and 1976, and all utilized perforated corrugated plastic tubing, of 4- to 6-inch diameter size, and nylon fabric filters. The evaluations reveal the ability of the 209 drain systems to discharge flow in the prescence of a groundwater flow source, with the surface of the groundwater variously ranging from 2 to 6 feet below the ground surface. The data displays a strong general disparity in the unit flow for systems installed by the trench and trenchless methods, with the trench method showing a noticeably higher flow performance for seemingly similar conditions. In repeated instances, the flow performances of systems installed by the trenchless method were less than that believed to be needed to satisfy minimal drainage coefficients for the area.

78:04B-007

ANALYSIS OF COMBINATION SURFACE-SUBSURFACE DRAINAGE SYSTEMS FOR HUMID REGION SOILS,

Skaggs, R.W.

North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.

Paper No. 78-2541, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 16 p. 13 fig, 5 tab, 20 ref, 3 equ.

Descriptors: Surface drainage, Subsurface drainage, Drainage systems, Drainage, Simulation analysis, Trafficability, Humid areas, Humid climates, Model studies, Crop production.

Various designs of combination surface-subsurface drainage systems were analyzed by simulating their performance over twenty-five years of climatological record. Simulations were conducted and results analyzed for four soils at three locations: Jacksonville, Florida, Wilmington, North Carolina, and Columbus, Ohio.

78:04B-008

INCORPORATING CROP NEEDS INTO DRAINAGE SYSTEM DESIGN,

Ravelo, C.J., Reddell, D.L., Hiler, E.A., and Skaggs, R.W.

Texas A & M University, College Station, Department of Agricultural Engineering.

Paper No. 78-2540, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, p 20.

Descriptors: Drainage practices, Drainage systems, Drainage, Computer models, Water table, Soil water, Soil-water-plant relationships, Simulation analysis, Crop production, Water management (applied).

An improved approach is proposed for incorporating crop drainage requirements into drainage design procedures. The overall methodology links crop drainage requirements, climatological data, and drainage theory into a workable design method through incorporation of the stress-day index concept into a water management model. (Skaggs, 1975. A water management model for high water table soils. Paper No. 75-2524, ASAE Winter Meeting.)

78:04B-009
SUBSURFACE DRAIN SPACING FROM WATER TABLE AND OUTFLOW MEASUREMENTS,
Michener, D.W., Schwab, G.O., Skaggs, R.W., Gordos, J.D., and Olosky, C.J.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Paper No. 78-2536, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 12 p. 2 fig, 8 tab, 6 ref.

Descriptors: Subsurface drains, Subsurface drainage, Water table, Drawdown, Hydraulic conductivity, Porosity, Discharge measurement, Soil texture, Design, Statistical methods.

Hydraulic conductivity and drainable porosity were determined from water table drawdown and outflow measurements for six fine-textured soils in Ohio. Drain spacings were computed for three drawdown rates with a coefficient of variation of about 30%. When drawdown was corrected for evapotranspiration, spacings were reduced about 16%.

78:04B-010
RESEARCH INTO THE EFFECTS OF ARTIFICIAL GROUNDWATER RECHARGE, LEA VALLEY, LONDON, ENGLAND,
Edworthy, K.J., Stott, D.A., and Wilkinson, W.B.
Water Research Centre, Medmenham, England, Resources Division.
Water Resources Bulletin, Vol. 14, No. 3, p 554-575, June, 1978. 11 fig, 2 tab, 9 ref.

Descriptors: *Groundwater, *Artificial recharge, *Recharge wells, *Lea Valley (England), *London Basin (England), Aquifers, Chalk, Sands, Wells, On-site investigations.

Large-scale groundwater abstraction from the Cretaceous Chalk/Lower Tertiary Basal Sands aquifer system of the London Basin in the last 150 years has developed storage of more than 1,000,000 cu m. Limited operational recharge was undertaken in the 1950's encouraging further detailed study of the wider possibilities. Following a comprehensive hydrogeological reappraisal, an economic and engineering study, and pilot-scale experiments, the Lea Valley was shown to have the greatest potential for recharge. Artificial recharge into the Chalk at a rate of 9,000 cu m/d appears possible, through acidized 900 mm diameter boreholes. An understanding of the degree of interconnection between the Chalk and Basal Sands and of the causes of changes in quality of recharge water during storage was shown to be of particular importance to the successful operation of any recharge scheme using this system. A two-layer numerical groundwater model of the 800 sq km area and a surface/groundwater simulation model was used to assist with the design of the 84,000 cu m/d prototype scheme, and also will help in assessing its efficiency. The models ultimately will be used to manage the operation of the first stage development, now coming into use.

78:04B-011
THREE-DIMENSIONAL MODELING OF GROUNDWATER FLOW SYSTEMS,
Frind, E.O., and Verge, M.J.
Waterloo University, Waterloo, Ontario, Canada N2L 3G1, Department of Earth Sciences.
Water Resources Research, Vol. 14, No. 5, p 844-856, October, 1978. 15 fig, 3 tab, 30 ref, 15 equ, 1 append.

Descriptors: Groundwater movement, Model studies, Finite element analysis, Continuity equation, Saturated flow, Unsaturated flow, Groundwater basins, Cost analysis, Feasibility studies, Computer models.

Practical aspects of three-dimensional (3-D) modeling of groundwater flow systems were closely examined. A Galerkin finite element model was designed with a view to providing flexibility, user convenience, and a high degree of efficiency, qualities which are critical to the success of 3-D modeling of real systems. The model was based on the general saturated-unsaturated continuity equation. Several integration schemes and matrix solvers were compared, and relative costs were expressed as functions of grid size. Examples presented include a hypothetical system and a real system. Simulation costs were generally found to be reasonable for grids of the size encountered with real systems. It was found that the remaining obstacle to the unified treatment of saturated-unsaturated systems was that the optimum element sizes required for saturated and unsaturated flow were not always compatible because of constraints arising from the physical properties of the materials. In general, however, it appeared that with presently available tools, 3-D analysis is a practical option.

78:04B-012
FINITE ELEMENT METHOD FOR SUBSURFACE HYDROLOGY USING A MIXED EXPLICIT-IMPLICIT SCHEME,
Narasimhan, T.N., Neuman, S.P., and Witherspoon, P.A.
California University, Berkeley, Lawrence Berkeley Laboratory.
Water Resources Research, Vol. 14, No. 5, p 863-877, October, 1978. 19 fig, 2 tab, 32 ref, 38 equ, 2 append.

Descriptors: Subsurface flow, Finite element analysis, Model studies, Computer programs, Groundwater movement, Aquifer management, Infiltration, Drainage, Saturated flow, Unsaturated flow.

The mixed explicit-implicit Galerkin finite element method developed previously by the authors was shown to be ideally suited for a wide class of problems arising in subsurface hydrology. These problems include confined saturated flow, unconfined flow under free surface conditions subject to the Dupuit assumption, flow in aquifers which are partly confined and partly unconfined, axisymmetric flow to a well with storage, and flow in saturated-unsaturated soils. A single computer program, entitled Flump, can handle all of these problems. The mixed explicit-implicit solution strategy employed in the program insured a high level of accuracy and computation efficiency in most cases. Some of the outstanding features of this solution strategy included an automatic control of time step size, reclassification of nodes from explicit to implicit during execution, automatic adjustment of the implicit time-weighting factor, and the treatment of boundary conditions and source terms as arbitrary functions of time of the state of the system. Five examples were presented to demonstrate the versatility and power of this new approach. A purely physical derivation of the finite element equations which does not rely on the Galerkin formalism was also included in one of the appendices.

78:04B-013
USE OF BOUNDING WELLS TO COUNTERACT THE EFFECTS OF PREEXISTING GROUNDWATER MOVEMENT,
Whitehead, W.R., and Langhetee, E.J.
Louisiana State University, Baton Rouge, Department of Petroleum Engineering.
Water Resources Research, Vol. 14, No. 2, p 273-280, April, 1978. 8 fig, 5 ref.

Descriptors: *Salaquifers, * Bounding wells, *Water storage, *Injection wells, *Underground storage, Groundwater movement, Potentiometric level, Least squares method, Computer programs.

Underground storage of freshwater in salaquifers is feasible under natural or man-made conditions. Since recovery efficiency is inversely proportional to the rate of groundwater flow, reducing the potentiometric gradient reduces fresh-water loss. This can be done by installing injection and producing bounding wells. A desired balanced potentiometric level was selected, then the required rates of the bounding wells were computed using a Fortran IV computer program which employed a least squares solution. The results of the computer runs indicated that bounding well flow rates vary directly with the magnitude of groundwater movement, inversely with the number of bounding well, and directly with the distance the wells are placed from the boundaries. The only limitations are that the distance should not be less than 30 degrees of the radius of the storage area, there should be at least one bounding well in each quadrant of the storage area, and the sum of the production rates must equal the sum of the injection rates. The latter limitation ensures that the environmental impact of the system is negligible. A cost comparison chart indicated that the in-place water cost at which a bounding well system will become economically attractive decreases as the volume stored increases.

78:04B-014
SHOULD INTEGRATE PEAK LOAD WITH WATER MANAGEMENT,
Irrigation Age, Management.
Irrigation Age, Vol. 13, No. 1, p 64, September, 1978. 1 fig.

Descriptors: Irrigation practices, Irrigation efficiency, Pumping, Energy, Sprinkler irrigation, Water reuse, Center pivot systems, Water pressure, Farm equipment, Fertilizers.

Center pivot irrigators who rely on electricity could save up to $72 million a year if more "integrated" peak electrical load and water management control systems were designed. And, the technical knowledge is available. At the same time, power suppliers would be able to more successfully deal with the problems of high peak electrical demands. The problem is that short term peaks require generation and transmission facilities that are under-utilized during much of the year. Key to success with an integrated approach is that irrigation scheduling techniques, geared to saving both water and energy, would be used. Savings in nitrogen, pumping costs and system wear could amount to another $60 million annually with better water management.

SECTION XVIII

WATER QUANTITY MANAGEMENT AND CONTROL

EFFECT ON WATER OF MAN'S NONWATER ACTIVITIES (GROUP 04C)

78:04C-001
TO SOLVE HIGHWAY AND FARM WATER MANAGEMENT PROBLEMS,
Smith, R.L., and Drablos, C.J.W.
Illinois University, Urbana, Department of Agricultural Engineering.
Agricultural Engineering, Vol. 59, No. 2, p 22-24, February, 1978. 4 fig.

Descriptors: Highway effects, Drainage, Drainage water, Soil erosion, Sedimentation, Legal aspects, Soil conservation, Water management (applied).

Wherever agricultural lands are crossed by highways, drainage interrelationships between the highway authorities and the adjoining landowners become complex. Engineering and legal judgment plays an important role in finding the satisfactory solutions to these problems. While it may be permissible to temporarily obstruct local highways with ponded water, eroded material, and debris, such conditions should not permanently exist on highways which are subject to heavy, high-speed traffic. And care must be exercised to reduce adverse effects on adjoining lands as a result of the highway facilities--for example, the diversion of water from natural water courses, the interception of subsurface drainage systems, the obstruction of the natural water flow. This paper discusses the various aspects of these problems and suggests how the magnitude of most problems can be reduced which will cause least disruption.

78:04C-002
DRAINAGE PRACTICE IN IMPERIAL VALLEY,
Hermsmeier, L.F.
Imperial Valley Conservation Research Center, United States Department of Agriculture-Agricultural Research Service, Brawley, California.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 1, p 105-109, February 20, 1978. 1 fig, 7 tab, 10 ref.
(See 78:03C-006)

SECTION XIX

WATER QUANTITY MANAGEMENT AND CONTROL

WATERSHED PROTECTION (GROUP 04D)

78:04D-001
EROSIONAL REMOVAL OF FALLOUT PLUTONIUM FROM A LARGE MIDWESTERN WATERSHED,
Sprugel, D.G., and Bartelt, G.E.
Argonne National Laboratory, Illinois, Radiological and Environmental Research Division.
Journal of Environmental Quality, Vol. 7, No. 2, p 175-177, April-June, 1978.
2 tab, 28 ref.

Descriptors: *Erosion, *Sediments, *Plutonium, Watersheds (basins), Sampling, Data processing, Sediment transport, Sorption, Soils, Soil erosion, Suspended solids.

The Great Miami River at Sidney, Ohio, drains a 1,401-sq km watershed which is generally flat and predominantly agricultural. Samples of river water collected over a wide range of flow and sediment loading conditions showed that the concentrations of 239, 240 Pu in filtered water and suspended sediment were fairly constant, which means of 0.15 fCi/liter for water and 14 fCi/g for suspended sediment. Plutonium concentrations in suspended sediment are somewhat higher than plow-layer soil concentrations, probably due to settling of larger soil particles in ponds and backwaters in the upper reaches of the river. Annual plutonium transport from the watershed by erosion averages 1.2 mCi, or 0.9 pCi/sq m, which is about 0.05% of the total plutonium in the watershed soil. The primary mechanism for plutonium removal is erosion of small soil particles to which the element is sorbed.

78:04D-002
EROSIONAL TRANSPORT AND DEPOSITION OF PLUTONIUM AND CESIUM IN TWO SMALL MIDWESTERN WATERSHEDS,
Muller, R.N., Sprugel, D.S., and Kohn, B.
Argonne National Laboratory, Illinois, Radiological and Environmental Research Division.
Journal of Environmental Quality, Vol. 7, No. 2, p 171-174, April-June, 1978.
4 fig, 1 tab, 18 ref.

Descriptors: *Sediment transport, *Sediment sorting, *Particle size, On-site investigations, Sediments, Radioisotopes, Plutonium, Cesium, Soils, Clays.

The soils and sediments of two small watersheds and their retaining ponds were sampled in a study of the erosional transport of plutonium and cesium in midwestern ecosystems. In a watershed which had been used exclusively for row crops, no relationship was observed between plutonium content of the sediments and location in the pond or clay content. In a pasture watershed, sorting of the eroded material had occurred prior to entry into the pond and also within the pond. Clay content in the pasture pond sediments was significantly higher than in the soils of the surrounding watershed and increased with increasing distance from the inlet. Plutonium concentration in the sediments was strongly correlated with clay content, reflecting the higher plutonium content of finer soil particles. Cesium behaved similarly to plutonium in the soils and sediments of both watersheds. Where sorting occurs, as in the pasture watershed, deposits of fine sediments will contain higher plutonium and cesium concentrations than in the original surface soil.

78:04D-003
TRANSPORT OF AGRICULTURAL CHEMICALS FROM SMALL UPLAND PIEDMONT WATERSHEDS,
Smith, C.N., Leonard, R.A., Langdale, G.W., and Bailey, G.W.
Environmental Research Laboratory, Athens, Georgia 30605 and Southern Piedmont Conservation Research Center, Watkinsville, Georgia 30677.

Publication No. EPA-600/3-78-056, May, 1978. 364 p, 96 fig, 177 tab, 41 ref, 8 append.

Descriptors: Herbicides, Fertilizers, Pesticides, Surface water runoff.

Data were collected from four small watersheds (1.3 to 2.7 ha) located in the Southern Piedmont region. Two watersheds were managed without conservation measures; the other two watersheds were parallel-terraced and included grassed waterways for soil erosion control. Total losses of applied herbicides were affected by the occurrence of runoff in close proximity to application date, mode of application, and persistence in the soil runoff zone. Most of the total annual losses by runoff were in the first three runoff events for all compounds except paraquat. Runoff of trifluralin was very low (0.1 to 0.3% of the annual application). Total runoff losses of other herbicides were commonly less than 1.0% except when runoff occurred shortly after application. Sediment yield from terraced watersheds was significantly less than from watersheds managed without terraces. Except for paraquat, however, pesticide yields in runoff were not reduced in proportion to sediment reduction because solution transport was the major mode of loss for the soluble herbicide phase. Annual runoff losses of soluble plant nutrients were 5.0 and 1.3 kg/ha for chloride and nitrate, respectively. Losses of soluble phosphorus from both watersheds were very low, about 380 g/ha.

78:04D-004
EFFECT OF MULCHING ON SEDIMENT IN RUNOFF FROM SIMULATED RAINFALL,
Singer, M.J., and Blackard, J.
California University, Davis, Department of Land, Air, and Water Resources.
Soil Science Society of America Journal, Vol. 42, No. 3, p 481-486, May-June, 1978. 2 fig, 2 tab, 22 ref.

Descriptors: *Erosion control, *Mulching, *Simulated rainfall, Laboratory tests, Erosion, Soil erosion, Litter, Leaves, Data processing, Sediments.

Simulated rainfall was used to test the relationship between sediment in runoff and percent of the soil that was mulch covered. Oak leaves, redwood litter, and oat straw were used as mulches on a 0.37 sq m plot of Auburn (loamy, mixed, thermic, Ruptic-Lithic Xerochrepts) surface soil at a 9% slope. Cover percentage was related to sediment in surface runoff by a parabolic relationship. The relationship between redwood and oak covers and sediment in runoff was not significantly different, but both were significantly different from oat straw. Cover shape or distribution of inter-cover space appears to be important in affecting sediment loss. Runoff volume was reduced significantly by high cover levels which protected the soil from sealing and helped maintain a high infiltration rate.

78:04D-005
A SEDIMENT GRAPH MODEL BASED ON AN INSTANTANEOUS UNIT SEDIMENT GRAPH,
Williams, J.R.
Agricultural Research Service, Temple, Texas, Grassland Forage Research Center.
Water Resources Research, Vol. 14, No. 4, p 659-664, August, 1978. 2 fig, 3 tab, 10 ref.

Descriptors: *Sedimentation rates, *Erosion, *Texas, *Storm runoff, *Model studies, Mathematical models, Sediments, Rainfall, Watersheds (basins), Land use.

A model was developed for predicting sediment graphs from agricultural watersheds. Storm sediment graphs were predicted by convolving source runoff with an instantaneous unit sediment graph (IUSG). The IUSG is the distribution of sediment from an instantaneous burst of rainfall producing one unit of runoff. The IUSG is the product of an instantaneous unit hydrograph and the sediment concentration distribution. Initial sediment concentration of IUSG was assumed to vary linearly with source runoff volume. A sediment-routing function, based on travel time and sediment particle size, was used to predict the sediment concentration distribution. Tests with 50 storms from 5 watersheds showed that the model is applicable to agricultural watersheds in the Texas blacklands. It should be useful in designing reservoirs or in water quality-modeling problems.

78:04D-006
FAILURE SEQUENCE OF GULLY HEADWALLS IN WESTERN IOWA,
Bradford, J.M., Piest, R.F., and Spomer, R.G.
Missouri Agricultural Experimental Station, Columbia.
Soil Science Society of America Journal, Vol. 42, No. 2, p 323-328, March, 1978.
6 fig, 1 tab, 20 ref.

Descriptors: *Erosion, *Iowa, *Missouri, *South Carolina, *Soil morphology, Soil strength, Sedimentation, Slope stability, Gully erosion, Loess.

A characterization of the failure sequence of gully headwalls and banks is necessary to predict gully erosion rates and to develop controls. A model was given for the sequential nature of gully growth in the thick loessial area of western Iowa. The failure sequence includes a popout or alcove failure near the toe of a near-vertical wall; columnar sloughing of the overhanging material; and finally, the transport of the eroded material downstream. The initiating failure at the base of the wall is a result of weakening of the soil material by wetting. The gully bank failure sequence and geometry in the western Iowa loess region were compared to gully erosion studies in the glacial drift region of northwestern Missouri and in the Piedmont of South Carolina.

78:04D-007
CONTROLLING DUST IN THE MOHAVE VALLEY,
Halderman, A.D.
Arizona Agricultural Experiment Station, Tucson.
Agricultural Engineering, Vol. 59, No. 2, p 25-26, February, 1978.

Descriptors: *Soil management, *Dust, *Air pollution, *Wind erosion, *Arizona, *Colorado River, *Mohave Valley (Arizona), Soil erosion, Land reclamation, Grading.

Land grading to adapt Indian lands for irrigated farming along the Colorado River in Mohave County, Arizona, has created dust problems severe enough to close schools and alarm health authorities. Between the removal of vegetation and the establishment of a crop, the land is particularly vulnerable to blowing. Members of the University of Arizona Department of Soils, Water and Engineering have offered several recommendations to alleviate the problem: Limiting the amount of land graded at any one time, coordinating clearing operations with prevailing winds to avoid blowing toward urban and commercial centers, digging wells to wet the land after brush removal and before grading, and the establishment of crops as soon as possible after grading. These recommendations can be adapted to local conditions and are presently being implemented.

78:04D-008
MAXIMUM NONEROSIVE FURROW IRRIGATION STREAM SIZE,
Hamad, S.N., and Stringham, G.E.
Utah State University, Logan, Department of Agricultural and Irrigation Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR3, Proceedings Paper 14021, p 275-281, September, 1978. 3 fig, 1 tab, 13 ref, 2 append.

Descriptors: *Furrow irrigation, *Erosion, *Irrigation ditches, Size, Slopes, Slope stability, Channels, Channel erosion, Channel flow, Irrigation, Surface irrigation, Soils, Water pollution, Sediments.

A technique was presented to predict maximum nonerosive irrigation stream size for furrows as a function of soil type and bed slope. Data for different soils and field conditions were analyzed to estimate the coefficients of a prediction equation. A table giving the estimated coefficients for each soil type was given.

SECTION XX

WATER QUALITY MANAGEMENT AND PROTECTION

IDENTIFICATION OF POLLUTANTS (GROUP 05A)

78:05A-001
IMPACT OF LAND USE ON GROUNDWATER QUALITY IN THE GRAND TRAVERSE BAY REGION OF MICHIGAN,
Rajagopal, R.
Duke University, Durham, North Carolina, School of Forestry and Environmental Studies.
Journal of Environmental Quality, Vol. 7, No. 1, p 93-98, January-March, 1978. 6 fig, 5 tab, 17 ref.

Descriptors: *Groundwater, *Water quality, *Land use, *Michigan, *Grand Traverse Bay Region (Michigan), Surveys, Sampling, Pollutants, Water pollution, Path of pollutants.

Investigations in townships surrounding the Grand Traverse Bay of Michigan showed an identifiable geographic relationship between groundwater quality and land use. Wells averaging 32 m deep in thinly populated areas measured an average of 3.75 ppm nitrate-N, indicating the effect of prolonged years of fertilizer application. Wells averaging 19 m deep in predominantly residential areas had an average of 1.31 ppm nitrate-N, indicating possible contamination from septic tank effluents. An average of 0.18 ppm of ammonia-N was detected in marshy wetlands. An analysis of temporal variations in groundwater quality with reference to precipitation, streamflow, and a trend component provided high as well as low R sq (0.92 to 0.12;R sq = square of the multiple correlation coefficient) producing regression models, indicating the effect of site specific conditions. A year-long observation of a sample well (43 m deep) surrounded by cherry orchards has an average of 18.25 ppm nitrate-N in a range of 13.09 to 20.64 ppm, almost double the standard considered safe for human consumption. Ammonia-N and chloride measurements from a shallow well (12.5 m deep), surrounded by residential and commercial activities, showed synchronized variations over a year (correlation coefficient r = 0.75, significant at 1% level), suggesting the existence of a common source of contamination. In summary, it was reiterated that the analysis of groundwater quality problems requires a different philosophical approach from the approaches used for water quantity and surface water quality modeling.

78:05A-002
ARSENIC POLLUTION FROM UNDERDRAINAGE AND RUNOFF FROM GOLF GREENS,
Duble, R.L., Thomas, J.C., and Brown, K.W.
Texas A & M University, College Station, Department of Soil and Crop Sciences.
Agronomy Journal, Vol. 70, No. 1, p 71-74, January-February, 1978. 4 fig, 6 ref.

Descriptors: Golf courses, Arsenicals (pesticides), Pollutants, Leachate, Runoff, Return flows, Sprinkler irrigation, Turf grasses.

A field study was conducted using four lysimeters (each 3 m by 3 m) containing a Tabor sandy loam soil (Udertic Paleustales) and 16 lysimeters containing different sand-soil-peat mixtures, each equipped with a gravel underdrainage system. Bermudagrass (Cynodon dactylan L.) turf was maintained at a height of approximately 1 cm of water daily. Tricalcium arsenate was applied on two dates at a rate of 88 kg ha^{-1}. Arsenic was found in significant concentrations in both drainage and runoff from lysimeters. Particularly high concentration (8 ppm As) were found in the drainage from plots previously cored for soil samples. Concentrations of As in the runoff were as great as 14 ppm when a heavy rain occurred shortly after application of $Ca3(AsO4)2$. Drainage from the plots typically contained 1 to 3 ppm and decreased slowly with time. Arsenic concentrations of 0.8 ppm were still found in the drainage 115 days after application. Concentrations of As in the runoff and drainage from all the plots exceeded acceptable limits for irrigation water established by the U.S. Public Health Service.

78:05A-003
ATRAZINE MOBILITY IN TWO SOILS UNDER CONVENTIONAL TILLAGE,
Hall, J.K., and Hartwig, N.L.
Pennsylvania Agricultural Experiment Station, University Park, Soil Chemistry and Weed Science.
Journal of Environmental Quality, Vol. 7, No. 1, p 63-68, January-March, 1978.
7 tab, 20 ref.

Descriptors: Pesticides, Herbicides, Leaching, Lysimeters, Bioassay, Soil contamination, Pennsylvania.

Atrazine mobility was studied in two different Pennsylvania soils under conventional tillage. Atrazine mobility, dissipation rate, and residual activity were evaluated by chemical analysis and oat bioassay of soil cores sampled at 15-cm increments to 122 cm and from chemical analysis of suction lysimeter leachates. It appeared from this study that application of atrazine to fine-textured, conventionally tilled soils at rates ranging from 1.0 to 4.5 kg/ha would not seriously affect groundwater supplies through contamination by internal soil damage.

78:05A-004
NITRATE ACCUMULATION IN SOILS AND LOSS IN TILE DRAINAGE FOLLOWING NITROGEN APPLICATIONS TO CONTINUOUS CORN,
Gast, R.G., Nelson, W.W., and Randall, G.W.
Minnesota University, St. Paul, Minnesota Agricultural Experiment Station.
Journal of Environmental Quality, Vol. 7, No. 2, p 258-261, April-June, 1978.
1 fig, 4 tab, 9 ref.

Descriptors: Nutrient removal, Denitrification, Nitrates, Tile drainage, Water pollution, Sweet corn, Minnesota.

Nitrate-N concentration in tile water, loss from tile lines, and accumulation in soil profiles were determined following each of three annual applications of 20, 112, 224, and 448 kg N/ha to continuous corn (Zea mays L.) grown on a Webster clay loam (Typic Haplaquoll) in southern Minnesota. Plots were isolated to a depth of 1.8 m with plastic to allow an accurate assessment of the area drained. There was relatively little increased N03-N accumulation in the soil profile or loss from tile lines at the recommended application rate of 112 kg N/ha compared to that for the check treatment. Nitrate-N losses through tile lines in 1975 (after 3 years treatment) were 19, 25, 59, and 120 kg/ha for the 20, 112, 224, and 448 kg N/ha applications, respectively, which had N03-N accumulations in the 0-3 m soil profiles of 54, 100, 426, and 770 kg N03-N/ha. Maximum N03-N accumulation in the soil profiles occurred at a depth of about 1 m with little evidence of movement below about 2.2 m.

78:05A-005
EFFECTS OF TRACE ELEMENTS ON NITRIFICATION IN SOILS,
Liang, C.N., and Tabatabai, M.A.
Iowa State University, Ames, Department of Agronomy.
Journal of Environmental Quality, Vol. 7, No. 2, p 291-293, April-June, 1978.
3 tab, 15 ref.

Descriptors: Nitrification, Inhibitors, Nitrates, Nitrites, Trace elements, Heavy metals, Pollutants.

Studies to evaluate the effects on nitrification of 19 trace elements showed that all these elements inhibited nitrification of NH4(+)-N added to soils. Results showed that the relative effectiveness of the trace elements in inhibition of nitrification depends on the soils. When the trace elements were compared to using 5 micromoles/g of soil, Ag(I), Hg(II), Cd(II), Ni(II), As(III), Cr(III), B(III), Al(III), Se(IV), and Mo(VI) were the most effective inhibitors (average inhibition >50%, and Mn(II) and Pb(II) the least effective (average inhibition <25%) inhibitors. The average inhibition by the elements Co(II), Cu(II), Sn(II), Fe(II), Zn(II), Fe(III), V(IV), and W(VI) ranged from 33% with W(VI) to 49% with Fe(III). Silver(I), Ni(II), Co(II), Zn(II), Mn(II), Pb(II), As(III), B(III), Fe(III), As(V), Mo(VI), and W(VI) inhibited Nitrobacter, causing accumulation of NO2(-)-N in one of the soils used.

78:05A-006
A METHOD FOR PARAMETER SENSITIVITY ANALYSIS IN DIFFERENTIAL EQUATION MODELS,
Kohberger, R.C., Scavia, D., and Wilkinson, J.W.
Albany Medical College, New York, Division of Computer Science.
Water Resources Research, Vol. 14, No. 1, p 25-29, February, 1978. 4 fig, 4 tab, 13 ref, 9 equ.

Descriptors: Mathematical models, Least squares method, Analytical techniques, Probability.

A numeric method for analyzing global parameter sensitivity about a fixed point in parameter space for differential equation models is presented. The method is suitable for large-scale, multiresponse systems which may not be in steady state. By using a quadratic model, the relationship between several global response characteristics and parameter perturbations is examined. Sensitivity relationships are defined with both backward elimination regression model selection procedures and eigenvalue-eigenvector analyses. An example of the method is given using an ecosystem model consisting of 14 coupled differential equations.

78:05A-007
DESIGN CONSIDERATIONS FOR AMBIENT STREAM QUALITY MONITORING,
Lettenmaier, D.P.
Washington University, Seattle, Department of Civil Engineering.
Water Resources Bulletin, Vol. 14, No. 4, p 884-902, August, 1978. 3 fig, 5 tab, 21 ref.

Descriptors: *Monitoring, *Water quality, *Network design, *Mathematical models, Networks, Sampling, Streams, Pollutants, Statistics, Statistical models.

Existing ambient water quality monitoring programs have resulted in data which are often unsuitable for assessment of water quality trends. A primary concern in designing a stream quality monitoring network is the selection of a temporal sampling strategy. It is extremely important that data for trend assessment be collected uniformly in time. Greatly superior trend detection power results for such a strategy as compared to stratified sampling strategies. In general, it is desirable that sampling frequencies be at least monthly but not greater than biweekly; higher sampling frequencies usually result in little additional information. An upper limit on trend detectability exists such that for both five and ten year base periods it is often impossible to detect trends in time series where the ratio of the trend magnitude to time series standard deviation is less than about 0.5. For the same record lengths, trends in records with trend to standard deviation ratios greater than about one usually can be detected with very high power when a uniform sampling strategy is followed.

78:05A-008
SAMPLING FREQUENCY FOR RIVER QUALITY MONITORING,
Sanders, T.G., and Adrian, D.D.
Colorado State University, Fort Collins, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 4, p 569-576, 1978. 5 fig, 3 tab, 25 ref.

Descriptors: *Sampling, *Monitoring, *Water quality, *Connecticut River, Control, Water analysis, Statistical methods, Chemical analysis, River basins, River flow.

Sampling frequency for a water quality monitoring network is presented, and for illustrative purposes the criterion is applied to the Massachusetts portion of the Connecticut River basin. The proposed frequency criterion is based upon the assumption that the primary objectives of future river quality monitoring networks are the determination of ambient water quality conditions and an assessment of yearly trends rather than detection of stream or effluent standards violations. The sampling frequency criterion is derived as a function of the random variability of the river flow. The criterion is specifically related to the magnitude of the expected half width of the confidence interval of the mean of the random component of the annual statistic--mean log river flow. The appropriate sampling intervals (at each sampling station within the river basin) are determined by specifying equality of this confidence interval half width, which insures a uniform reliability of the annual statistic.

78:05A-009
FIELD MEASUREMENT OF DENITRIFICATION,
Rolston, D.E., and Broadbent, F.E.
California University, Davis, Department of Land, Air and Water Resources.
Report No. EPA-600/2-77-233, November, 1977. 75 p, 40 fig, 15 tab, 13 ref.

Descriptors: *Denitrification, *Soil moisture, *Vegetation effects, *Gas flux, Irrigation, Nitrates, Nitrites, Nitrogen compounds, Soil environment, Soil management.

Denitrification from a Yolo loam field profile was studied in relation to the influence of soil-water content, organic carbon source, and temperature. Field plots were instrumented with soil atmosphere samplers, soil solution samplers, and tensiometers. The two soil-water pressure treatments were applied in topsoil. Three levels of soil carbon were studied by evaluating plots cropped with ryegrass, uncropped plots, and plots amended with manure. Experiments were conducted at soil temperatures of 8 and 23C. Fertilizer was applied as KN03 enriched with N15. The flux of volatile gases at the soil surface was measured from the accumulation of N20 and nitrogen gas isotopes beneath an airtight cover placed over the soil surface. Denitrification at 23C ranged from 73% of the fertilizer nitrogen for the manure treatment to 1% for the uncropped treatment. At 8C, denitrification ranged from 11% for the manure treatment to zero for uncropped plots. The nitrite flux at the soil surface varied between 5 and 26% of total denitrification. The results demonstrated that denitrification of soil can occur at high rates (highest soon after application of N03(-) fertilizer to wet soil), and that the presence of a crop root system has a large positive influence on denitrification.

78:05A-010
CARBON CONTENTS AND SOURCES IN GROUNDWATERS OF THE CENTRAL PLATTE REGION IN NEBRASKA,
Spalding, R.F., Gormly, J.R., and Nash, K.G.
Nebraska University, Lincoln, Conservation and Survey Division.
Journal of Environmental Quality, Vol. 7, No. 3, p 428-434, July-September, 1978.
2 fig, 3 tab, 23 ref.

Descriptors: *Groundwater, *Dissolved oxygen, *Dissolved organic carbon, *Carbon, *Nebraska, *Platte River (Nebraska), *Alkalinity, Water chemistry, Water wells, Land use.

Fifty-one groundwater samples collected in a losing reach of the Platte River were analyzed for alkalinity, dissolved oxygen (DO), and dissolved organic carbon (DOC). Ranges in concentrations were 24.8 to 109 mg/liter, .0 to 5.5 mg/liter, and 0.5 to 4.8 mg/liter for organic carbon, DO, DOC, respectively. The concentrations of these constituents are primarily associated with land use and well depth. Carbon isotope fractionation can be useful in determining sources of organic carbon to the groundwater.

78:05A-011
AN IMPROVED SOIL-SAMPLING PROCEDURE FOR THE PREDICTION OF DISSOLVED INORGANIC PHOSPHATE CONCENTRATIONS IN SURFACE RUNOFF FROM PASTURE,
Sharpley, A.N., Syers, J.K., and Tillman, R.W.
Massey University, Palmerston North, New Zealand, Agricultural and Horticultural Sciences.

Journal of Environmental Quality, Vol. 7, No. 3, p 455-456, 1978. 3 fig, 1 tab, 3 ref.

Descriptors: *Phosphates, *Agricultural runoff, *Soil analysis, *Sampling, *Phosphorus compounds, *Dissolved inorganic phosphates, *Phosphate transport, *Soil sampling procedure, *Surface-runoff plots, Soil sampling.

Linear relationships were obtained between the mean concentration of dissolved inorganic phosphate (DIP) in each of several surface-runoff events and the amounts of inorganic P extracted by 0.1M NaCl from the top 1 cm of soil sampled prior to the event. These relationships were similar for both unfertilized and fertilized, undrained pasture. This contrasted with the data obtained in the previous year for the same surface-runoff plots, receiving the same treatments, where markedly different linear relationships were obtained using a 0.5 cm soil-sampling depth. The modified soil-sampling procedure provides more generally applicable method of predicting the concentration of DIP in surface runoff from pastures of widely differing P status.

78:05A-012
PRECIPITATION AND THROUGHFALL CHEMISTRY IN THE SAN FRANCISCO BAY AREA,
McColl, J.G., and Bush, D.S.
California University, Berkeley, Department of Soils and Plant Nutrition.
Journal of Environmental Quality, Vol. 7, No. 3, p 352-357, July-September, 1978. 3 fig, 1 tab, 36 ref.

Descriptors: Precipitation (atmospheric), Throughfall, Rainfall, Chemical analysis, Forest soils, Air pollution, Nutrients, Acidity, California.

At Berkeley, California, main ionic constituents of bulk precipitation during the wet season of 1974-1975 were S04(2-), Cl(-), HC03(-), Na(+), and Ca(2+), and mean H(+) concentration was 10.7 ± 1.5 microequivalents/liter (pH 5.0). Although S04(2-) comprised 50% of the anions in bulk precipitation, H(+) concentration had the highest correlation with N03(-). Impacted air pollutants accumulated on tree leaves between major rainstorms. Atmospheric N and S were correlated with N03(-) and S04(2-) in bulk precipitation and leafwash in a Eucalyptus globulus forest. Ionic composition of bulk precipitation resembled that of surface-soil solution in an adjoining, recently clear-cut area.

78:05A-013
METABOLISM OF NITROPHENOLS IN FLOODED SOILS,
Sudhakar-Barik, and Sethunathan, N.
Central Rice Research Institute, Cuttack-753006, India, Laboratory of Soil Microbiology.
Journal of Environmental Quality, Vol. 7, No. 3, p 349-352, July-September, 1978. 4 tab, 12 ref.
(See 78:02K-049)

78:05A-014
BIOLOGICAL HYDROLYSIS OF PARATHION IN NATURAL ECOSYSTEMS,
Sudhakar-Barik, and Sethunathan, N.
Central Rice Research Institute, Cuttack-753006, India, Laboratory of Soil Microbiology.
Journal of Environmental Quality, Vol. 7, No. 3, p 346-348, July-September, 1978. 5 tab, 11 ref.
(See 78:02K-053)

78:05A-015
SOME PROPERTIES OF THE GEOMETRIC MEAN AND ITS USE IN WATER QUALITY STANDARDS,
Landwehr, J.M.
Geological Survey, Reston, Virginia, Water Resources Division.
Water Resources Research, Vol. 14, No. 3, p 467-473, June, 1978. 4 fig, 7 tab, 17 ref.

Descriptors: *Water quality standards, *Coliforms, *Water analysis, *Analytical techniques, *Statistical methods, *Swimming facilities, *Geometric mean, Properties, Sampling, Evaluation.

The geometric mean is often used to express acceptable levels of fecal coliform counts in Federal and State water quality criteria or standards. The expected value of the geometric mean is shown to be a function of the sample size and to be very sensitive to the skew as well as to the form of the underlying distribution function. Implications of these findings are discussed with regard to standards. In particular, it is noted that great care must be taken in specifying the minimal sample size to be used.

78:05A-016
ESTIMATION AND MANAGEMENT OF THE CONTRIBUTION BY MANURE FROM LIVESTOCK IN THE ONTARIO GREAT LAKES BASIN TO THE PHOSPHORUS LOADING OF THE GREAT LAKES,
Draper, D.W., Robinson, J.B., and Coote, D.R.
Guelph University, Guelph, Ontario, Canada, Department of Environmental Biology.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 159-174. 2 fig, 4 tab, 39 ref, 3 equ.

Descriptors: Agricultural runoff, Nutrient removal, Phosphorus, Livestock, Great Lakes, Water pollution, Water quality, Feed lots.

As part of the work of the International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG) a simple model has been developed for estimating contributions of total phosphorus to Great Lakes tributary loading originating with livestock manure produced in the Basin. Total loads attributable to livestock sources and a range of probable unit loads on a per animal unit per year basis were calculated.

78:05A-017
PHOSPHORUS--A POTENTIAL NONPOINT SOURCE POLLUTION PROBLEM IN THE LAND AREAS RECEIVING LONG-TERM APPLICATION OF WASTES,
Reddy, K.R., Khaleel, R., Overcash, M.R., and Westerman, P.W.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 193-211. 7 fig, 7 tab, 29 ref, 3 equ.

Descriptors: Wastes, Phosphorus, Water quality, Runoff, Water pollution sources, Nutrients, Water pollution.

The main objective of this work was to describe the P behavior in the soils treated with wastes and their relationship to the surface water quality. The results obtained from these studies indicated that application of animal wastes decreased P sorption capacity of the soil and increased P concentration in the soil solution, thus increasing the equilibrium P concentration (EPC), at which no net adsorption or desorption takes place. A significant relationship was observed between EPC values and P extracted with dilute acid (0.05 N HCl + 0.025 N H_2SO_4). Continuous application of wastes with high loading rates of P resulted in P movement into deeper layers. Transport of P either into deeper soil layers or in the surface runoff water was dependent on the availability of soluble P in the soil surface at the time of rainfall event. Simple equations were developed to describe the availability of P at the soil surface, and the processes controlling P availability were also taken into consideration.

78:05A-018
ANIMAL MANURE MOVEMENT IN WINTER RUNOFF FOR DIFFERENT SURFACE CONDITIONS,
Thompson, D.B., Loudon, T.L., and Gerrish, J.B.
Minnesota University, St. Paul, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 145-157. 1 fig, 4 tab, 16 ref.

Descriptors: Agricultural runoff, Water quality, Water pollution, Nutrient removal, Runoff, Return flow, Water quality control, Chemical oxygen demand, Chemical degradation.

This experiment was designed to observe the impact of selected management practices on winter runoff quality. The effects of various surface conditions and buffer zones on runoff quality associated with land application of animal waste on frozen, snow-covered soil were evaluated. Three different surface covers with two lengths of buffer zone were compared as management practices which could be utilized for the reduction of nutrients contained in runoff from land application areas. The surface conditions used for the plots were corn stalk stubble with rows running across the slope, corn stalk stubble which had been fall disked across the slope, and established orchard grass. Runoff samples were analyzed for concentrations of ammonia, total Kjeldahl nitrogen, total phosphorus, chemical oxygen demand (COD), total and volatile solids. Twelve plots were established on a Hillsdale sandy loam soil with a 3.5% slope. The plots were 3 x 58 meters with the upslope 3 x 24 meters receviing the manure application. Four plots were used for each surface conditions, two control and two spread with 62.7 M ton/ha of fresh dairy manure. The results of the experiment have been reported with discussion.

78:05A-019
ESTIMATING PHOSPHORUS LOADING FROM LIVESTOCK WASTES: SOME WISCONSIN RESULTS,
Moore, I.C., Madison, F.W., and Schneider, R.R.
Wisconsin University, Madison, Water Resources Center.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 175-192. 3 fig, 7 tab, 17 ref.

Descriptors: Wastes, Water pollution, Water pollution control, Livestock, Water quality control, Phosphorus, Agricultural watersheds, Pollutant identification, Agricultural runoff, Analytical techniques.

A description of an approach used to estimate phosphorus loading to the Great Lakes from livestock wastes in Wisconsin was presented. The results reported represent minimum annual loadings of total phosphorus to Lake Superior and Lake Michigan from areas of Wisconsin in these drainage basins. Estimates of the total phosphorus reaching surface waters from manure sources in the rest of the state were made on a per animal unit basis. The analytical techniques employed were reported separately. The emphasis was placed on the data requirements of the analysis. A key assumption of the methodology is that phosphorus in surface runoff will be linearly attentuated as long as the overland flow remains unchannelized. Thus, data on the location of barnlots and manure-spread fields with relation to surface features capable of channelizing flow were considered to be of primary importance. Problems encountered in determining this distribution of animal concentrations with respect to channels over a large and physiographical diverse region were discussed.

78:05A-020
NUTRIENT AND PESTICIDE MOVEMENT FROM FIELD TO STREAM: A FIELD STUDY,
Baker, J.L., Johnson, H.P., Borcherding, M.A., and Payne, W.R.
Iowa State University, Ames, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 213-245. 10 fig, 7 tab, 21 ref.

Descriptors: Nutrient removal, Pesticide removal, Agricultural runoff, Hydrologic aspects, Nitrogen, Phosphorus, Water quality, Water pollution, Mathematical models, Sedimentation.

The general objective of this field study is to provide a better understanding of the relationships between management farm systems and stream water quality and to enable analysis of such systems using mathematical models. Specific objectives are (1) to collect data to refine an Agricultural Runoff Model proposed by U.S. Environmental Protection Agency; (2) to relate runoff and soil-erosion nutrient (nitrogen and phosphorus) losses to hydrologic factors as altered by land management; (3) to relate losses of pesticides in runoff to pesticide properties and to hydrologic and management factors; and (4) to relate sedimentation to hydrologic and management factors. In this paper, the study was described and initial results were presented.

78:05A-021

SEARCH FOR NITRIFYING AGENTS IN WATER AND SOILS AS SOURCES OF NITRATES IN SURFACE WATER,

Phillips, N.A., and Todd, R.L.

Georgia University, Athens, Department of Agronomy and Institute of Ecology.

Technical Completion Report, USDI/OWRT Project No. A-066-GA, February, 1978.

89 p, 9 tab, 61 ref, 1 append.

Descriptors: Nitrogen, Nitrates, Surface waters, Nitrification, Small watersheds, Forest watersheds, Agriculture, Land use, Soil bacteria, Water quality.

The soil and surrounding water of seventeen diverse types of watersheds were analyzed over a one-year sampling period for a variety of parameters. Terrestrial nitrifying populations were quantified. Concentrations of ammonia, nitrate, and total nitrogen and pH were measured from soil extracts. The water was analyzed for concentrations of nitrate, ammonia, and seven selected cations. The terrestrial nitrifying bacteria were found to be positively correlated to nitrate and cation loss from so-called "natural" systems, i.e., ones that were not fertilized. Those heavily managed (fertilized) systems showed no relationship between nitrate and cation discharge and numbers of nitrifying bacteria. The average concentration of nitrate-nitrogen lost from natural systems was 0.07 mg/l over the year. That lost from the fertilized systems averaged 0.47 mg/l, approximately a 7-fold increase. Similiar relationships were found for average cation discharge.

78:05A-022

SOIL WATER CONTENT AND TEMPERATURE AS FACTORS IN THE VOLATILE LOSS OF APPLIED MERCURY (II) FROM SOILS,

Landa, E.R.

Oregon State University, Corvallis, Departments of Soil Science and Agricultural Chemistry.

Soil Science, Vol. 126, No. 1, p 44-48, July, 1978. 2 fig, 1 tab, 16 ref.

Descriptors: Mercury, Volatility, Soil contamination, Moisture content, Soil temperature, Pollutants, Pollutant identification, Water pollution sources.

Five surface soils from southeastern Montana were studied to determine the effects of soil water content and temperature on the volatile loss of applied divalent inorganic mercury. Soils were amended to 1 ppm Hg as 203 Hg-Hg(NO3)2. The water content studies involved soil samples at room temperature (18-25°C), either allowed to air-dry or maintained near the 1/3-bar or the 80% saturated moisture levels. The temperature studies involved samples at the 1/3-bar moisture level maintained at either 10°C, room temperature, or 35°C. Residual Hg content was monitored for 5-7 weeks. Hg losses were higher at the 1/3-bar moisture content than at air-dryness or 80% saturation. At 35°C the initial Hg loss rate was accelerated with respect to room temperature, while at 10°C, losses were considerably reduced.

SECTION XXI

WATER QUALITY MANAGEMENT AND PROTECTION

SOURCES AND FATE OF POLLUTION (GROUP 05B)

78:05B-001
NITROGEN FERTILIZER AND NITRATE CONCENTRATIONS IN TRIBUTARIES OF THE UPPER SANGAMON RIVER IN ILLINOIS,
Klepper, R.
Washington University, St. Louis, Missouri, Center for the Biology of Natural Systems.
Journal of Environmental Quality, Vol. 7, No. 1, p 13-22, January-March, 1978. 1 fig, 9 tab, 12 ref, 1 append.

Descriptors: *Nitrates, *Water pollution, *Fertilizers, *Farm management, *Illinois, Regression analysis, Drainage, Tributaries, Soybeans, Data collections.

Cross section multiple regressions were used to test the importance of nitrogen fertilizer use for variations in the nitrate nitrogen concentrations in 16 small tributaries of the Sangamon River in east central Illinois. Data were collected and regressions were run for two years, 1974 and 1975. Nitrate nitrogen concentrations in the spring of each year were regressed on estimated nitrogen fertilizer use per hectare of watershed in the previous crop or calendar year and on variables representing other aspects of agronomic practice and hydrologic features. The fertilizer data were collected by surveying approximately 300 farmers. Nitrate nitrogen concentrations were measured at four-week intervals. The regression results are not clear-cut but lend support to nitrogen fertilizer use as an important explanatory variable for variations in nitrate nitrogen concentrations.

78:05B-002
POLLUTANT CONTRIBUTIONS FROM IRRIGATION SURFACE RETURN FLOWS,
Miller, W.W., Guitjens, J.C., Mahannah, C.N., and Joung, H.M.
Max C. Fleischmann College of Agriculture, Reno, Nevada.
Journal of Environmental Quality, Vol. 7, No. 1, p 35-40, January-March, 1978. 2 fig, 5 tab, 10 ref.

Descriptors: Water pollution effects, *Water quality control, *Water pollution sources, *Flood irrigation, *Nevada, *Return flow, Water sampling, On-site investigations, Surface-groundwater relationships, Oxidation.

Four study sites, located in the Carson River Basin, Nevada, containing approximately 500,000 acres irrigated by surface flooding, were selected for a two-year investigation of causes and sources of irrigation surface return flow pollution and the interrelationships among pollution components. Irrigation applications and surface return flows were metered, net applied water was computed, and volume of infiltrated water was determined, based on water sampling and laboratory analysis of DO, BOD, TDS, NO3, -N, TN, PO4-P, and TP. Phosphate content was determined, via the persulfate digestion method. Filterable orthophosphate was determined by the ascorbic acid method. Study conclusions suggest: (1) BOD, and to a less extent, P4-P, are identified as major pollutants; (2) significant decrease in DO is noted as water moves from head to tail; (3) diffuse subsurface return flows appear to be sources of certain pollutants for surface water; and (4) water quality differences may be attributed in part to changes in water quantities, suggesting the need for further investigation.

78:05B-003
EFFECTS OF SOIL, COVER CROP, AND NUTRIENT SOURCE ON AMOUNTS AND FORMS OF PHOSPHORUS MOVEMENT UNDER SIMULATED RAINFALL CONDITIONS,

Reddy, G.Y., McLean, E.O., Hoyt, G.D., and Logan, T.J.
Ohio Agricultural Research and Development Center, Wooster.
Journal of Environmental Quality, Vol. 7, No. 1, p 50-54, January-March, 1978.
1 fig, 4 tab, 20 ref.

Descriptors: *Phosphorus, *Runoff, *Sediments, *Laboratory tests, *Path of pollutants, Erosion, Soil erosion, Soils, Leachate, Chemical analysis.

Three soils (Toledo silty clay, Rossmoyne silt loam, and Wauseon sandy loam) in greenhouse microplots were treated with chemical, chemical + straw, and manure sources of N, P, and K, were cropped or left bare, and were subjected to simulated rainfall. Phosphorus moving in runoff sediments, runoff solution, and leachate was measured. Most P moved as a component of sediments. Cropping decreased sediment and solution losses, while manure generally increased losses in both. Most P moving in runoff solution was inorganic. However, except where percolation swept inorganic P downward without reaction with the soil, most P moving in leachate was organic. Fractionations of soil P revealed that P treatments increased the HN4Cl- and NH4F-extractable fractions markedly, had less effect on the NaOH-extractable fraction, and had still less effect on the H2SO4-extractable and organic fractions. All phosphorus sources markedly increased the equilibrium P concentrations (EPC) of all soils. Manure increased EPC more than the other sources in the Rossmoyne and Wauscon soils. The tendency is for more sediment P to be lost from manure and for manure-treated soil to mobilize P into solution, make erosion control especially important if much manure is to be applied to soils and if eutrophication of surface waters is to be minimized.

78:05B-004
SURVIVAL AND MOVEMENT OF FECAL INDICATOR BACTERIA IN SOIL UNDER CONDITIONS OF SATURATED FLOW,
Hagedorn, C., Hansen, D.T., and Simonson, G.H.
Oregon State University, Corvallis, Department of Microbiology.
Journal of Environmental Quality, Vol. 7, No. 1, p 55-59, January-March, 1978.
2 fig, 3 tab, 8 ref.

Descriptors: *Bioindicators, *Septic tanks, *Soil disposal fields, *Water pollution sources, *Sewage bacteria, Disposal, Soil contamination, Public health, Coliforms, Bacteria.

Antibiotic-resistant fecal bacteria were used to monitor the degree of movement and subsequent groundwater contamination by septic tank effluent discharged into a drainfield under saturated conditions. Two pits of different depths were constructed to simulate drainfield beds, and groundwater samples were removed during thirty-two day sampling intervals from sampling wells installed at set distances from each inoculation pit. The bacteria added to the deep pit were released into a B2t horizon which contained a higher clay content than the A horizon in which the shallower pit was installed. Streptomycin-resistant strains of Escherichia coli and Streptococcus faecalis amended to each pit site moved in a directional manner, required more time to reach sampling wells when inoculated into the deeper of the two pits, and moved relatively long distances when considering that the area where the sites were located had only a 2% slope. Bacterial numbers peaked in the sampling wells in association with major rainfall patterns and the populations required longer periods to peak in the wells furthest from the inoculation pits. The results indicated that antibiotic-resistant bacteria eliminated the problem of differentiating between the amended bacteria and those nonresistant strains already in the soil, and the potential is excellent for including this type of microbiological procedure for assessing the suitability of a soil site for septic tank and waste water drainfield installations.

78:05B-005
VIRUS ADSORPTION BY FIVE SOILS,
Burge, W.D., and Enkiri, N.K.
Agricultural Research Service, Beltsville, Maryland, Agricultural Environmental Quality Institute.
Journal of Environmental Quality, Vol. 7, No. 1, p 73-76, 1978. 4 fig, 3 tab, 14 ref.

Descriptors: *Bacteriophage, *Soil types, *Clay loam, *Silts, *Adsorption, Waste water treatment, Sands, Loam, Sodium chloride, Cation exchange.

The Freundlich isotherm was applied to the adsorption kinetics of phi X-174 bacteriophage in five soil types with varying physical and chemical properties. Adsorption rates of 6 ml of the bacteriophage were observed in 6 g samples of Aastad clay loam, Kranzburg silt loam, Palouse silt loam, Parshall silt loam, and Quincy loamy sand. The Freundlich isotherm and adsorption rate constants were calculated for adsorption of the virus by the soil were also determined. The Quincy soil with a pH of 7.2 showed no adsorption of the virus, due possibly to its high organic content. Bacteriophage adsorption was represented as a function of the square root of time. The cation exchange capacity, specific surface area, and organic carbon content of the soil correlated with the virus adsorption rates of the four remaining soils. The influence of pH was found to be significant in the adsorption of the virus by the soil.

78:05B-006
TRANSPORT OF ATRAZINE AND SIMAZINE IN RUNOFF FROM CONVENTIONAL AND NO-TILLAGE CORN,
Triplett, G.B., Jr., Conner, B.J., and Edwards, W.M.
Ohio Agricultural Research and Development Center, Wooster.
Journal of Environmental Quality, Vol. 7, No. 1, p 77-84, January-March, 1978.
1 fig, 7 tab, 25 ref.

Descriptors: *Herbicides, *Runoff, *Weed control, *Farm management, Storm runoff, Rainfall, Corn (field), Precipitation (atmospheric), Pollutants, Crops.

On 0.4- to 3.5-ha watersheds, highest concentrations of atrazine (0.48 ppm) and simazine (1.2 ppm) were present in runoff occurring soon after application and declined rapidly for later events. Quantity of herbicides transported increased with the amount of runoff and was inversely related to the length of time between application and the runoff event. A maximum of 6% of the applied herbicide was transported from the field even under the most favorable conditions, and the average for all watersheds was less than 2%. Less runoff and herbicide loss occurred from areas planted to no-tillage than to conventional corn. In a multiple regression analysis of the factors, the natural logarithm (ln) of days after application and a tillage X application rate interaction were useful in predicting the natural logarithm of herbicide concentration in runoff. Factors from the multiple regression analysis used in this study were important in predicting concentration of atrazine and other pesticides when applied to data published by other workers.

78:05B-007
PHOSPHATE ADSORPTION-DESORPTION CHARACTERISTICS OF SUSPENDED SEDIMENTS IN THE MAUMEE RIVER BASIN OF OHIO,
Green, D.B., Logan, T.J., and Smeck, N.E.
Ohio Agricultural Research and Development Center, Wooster, Department of Agronomy.
Journal of Environmental Quality, Vol. 7, No. 2, p 208-212, April-June, 1978.
3 fig, 3 tab, 15 ref.

Descriptors: *Phosphates, *Eutrophication, *Algae, Ohio, Water pollution, *Phosphorus compounds, Water properties, Calcite, Surface runoff, Soil erosion.

Phosphorus (P) adsorption-desorption characteristics of Maumee River Basin suspended sediments were compared with those of Basin soils and stream bottom sediments. Suspended sediment contained more total P than either soils or bottom sediments. The increase in total P over soils is attributed to enrichment of P in sediment by selective erosion of fine particles and adsorption of P during fluvial transport. The suspended sediment had higher adsorption maxima than Basin soils, but lower than bottom sediments, and had lower adsorption energies than either soils or bottom sediments. Calcite content of the suspended sediments was correlated positively with total P, EPC (equilibrium P concentration), and P desorbed and negatively correlated with adsorption energy, implying that, although calcite is a sink for P, the adsorption is weak compared with other sites for P adsorption such as hydrous oxides of Fe and Al.

78:05B-008
SEASONAL RUNOFF LOSSES OF NITROGEN AND PHOSPHORUS FROM MISSOURI VALLEY LOESS WATERSHEDS,
Alberts, E.E., Schuman, G.E., and Burwell, R.E.
Journal of Environmental Quality, Vol. 7, No. 2, p 203-208, April-June, 1978.
6 tab, 21 ref.

Descriptors: *Phosphates, *Nitrogen, *Missouri, *Iowa, *Surface runoff, *Water quality, *Soil erosion, *Nutrient removal, Phosphorus compounds, Sediments.

Seasonal losses of nitrogen and phosphorus in surface runoff were determined for a seven-year period from three corn-cropped watersheds in southwestern Iowa. Three seasonal periods were defined: fertilizer, seedbed, and establishment period from April through June (P1); reproduction and maturation period from July through November (P2); and residue period from December through March (P3). Most of the average annual total N and P losses were associated with the sediment portion of runoff and occurred during P1. The extreme susceptibility of the loess soils to erosion during P1 must be taken into account when designing conservation practices to control plants nutrient losses. Seasonal discharges of runoff, sediment, and nutrients were much lower from a level-terraced watershed than from two contour-farmed watersheds, which demonstrates the benefit of terracing in resource conservation. Average annual soluble N and P losses were quite low and never exceeded 1% of the annual fertilizer application. These losses were the highest during P3 from the contour-farmed watersheds. Water and sediment weighted nutrient concentrations were the highest from the contour-farmed watersheds during P3, when residues covered the soil surface. Leaching of soluble nutrients from the residue and the greater selectivity of the soil erosion process for the finer fractions of the soil (i.e., clay and organic material) during snowmelt runoff are probably the factors responsible.

78:05B-009
A WATER QUALITY PLANNING MODEL WITH MULTIPLE TIME, POLLUTANT, AND SOURCE CAPABILITIES,
DeLucia, R., McBean, E., and Harrington, J.
Meta Systems Inc., Cambridge, Massachusetts.
Water Resources Research, Vol. 14, No. 1, p 9-14, February, 1978. 4 fig, 12 ref.

Descriptors: *Water pollution control, *Planning, *Waste treatment, Constraints, Optimization, Mathematical models, Systems analysis, Economies of scale.

The imposition of recent U.S. legislative requirements (Public Law (PL) 92-500) with the 1977 and 1983-1985 water quality goals requires that water quality management plans must weigh both degree of treatment and capacity expansion questions. A planning model capable of reflecting the implications of the pollutant constraints and the scale economies of point source abatement implicit in the legislation is developed. The model captures within a mathematical programming format important characteristics of decisions associated with the time-related water pollution control goals of PL 92-500. The model's unique features are the utilization of a biomass potential parameter as a measure of water quality and a set of heuristic procedures involving linearization of the waste treatment capacity-removal curves. These features allow avoidance of nonconvexity problems associated with analogous models. The model also includes the usual BOD, DO, N, and P water quality measures; it was applied in a recent planning study for the Saint John Basin in Maine.

78:05B-010
STEADY STATE RIVER QUALITY MODELING BY SEQUENTIAL EXTENDED KALMAN FILTERS,
Bowles, D.S., and Grenney, W.J.
Utah Water Research Laboratory, Logan.
Water Resources Research, Vol. 14, No. 1, p 84-96, February, 1978. 11 fig, 3 tab, 14 ref, 1 append.

Descriptors: *Water quality, *Utah, *Rivers, *Model studies, *Mathematical models, Pollutants, Dissolved oxygen, Water pollution, Biochemical oxygen demand, Algae.

Sequential extended Kalman filters (EKF) were applied as a technique for steady-state river water quality modeling. The approach was demonstrated by using water quality data collected over a 36.4-mi stretch of the Jordan River, Utah. Each EKF was used to represent a river reach in which hydraulic and quality characteristics were judged fairly uniform. Mean and variance boundary conditions between successive filters were adjusted to represent the effects of variance estimates of the system state (water quality parameters) and confidence intervals on these estimates were provided by combining two independent estimates of the system state. The independent estimates were based on (1) predictions from an "internally meaningful" model of the stream transport processes and biochemical transformations, and (2) measurements of the water quality parameters. The estimates were combined by a weighting procedure based on uncertainties associated with each estimate. A smoothing algorithm also was applied in order that estimates from passes of the filter procedure in both the downstream and upstream directions could be combined. In this way, information contained in the measurements was used both upstream and downstream of the location of the measurement. The calibration capability of the filter procedure was demonstrated by simultaneous estimation of the state vector and one of the model coefficients. This capability also was used to estimate simultaneously the rate of lateral loading for one of the water quality parameters. Simultaneous estimation of coefficients of lateral loading was shown to increase the uncertainty associated with filter estimates because of the inclusion of uncertainty associated with these coefficients and lateral loading rates.

78:05B-011
EFFECT OF SOIL MIXTURES AND IRRIGATION METHODS ON LEACHING OF N IN GOLF GREENS,
Mitchell, W.H., Morehart, A.L., Cotnoir, L.J., Hesseltine, B.B., and Langton, D.N., III.
Delaware University, Newark, Department of Plant Science.
Agronomy Journal, Vol. 70, No. 1, p 29-35, January-February, 1978. 5 fig, 5 tab, 15 ref.

Descriptors: Leaching, Golf courses, Nitrogen, Nitrates, Mixing, Sprinkler irrigation, Subsurface irrigation, Environmental effects, Turf grasses, Inhibitors.

The influence of soil mixtures, irrigation systems, and N sources on N leaching was studied in experimental, though functional, golf greens from 1973 to 1976. Sprinkler irrigation was compared with subsurface irrigation. Soil mixtures contained from 60 to 80 percent sand and variable amounts of silt loam topsoil, calcined clay and humus. Nitrogen treatments included activated sewage sludge, ureaform, ammonium nitrate, 30% N solution, anhydrous ammonia and nitrapyrin. Nitrogen leached primarily as NO3-N. Even though about 75% of the added was NH4-N, N solution (30% N) applied through the subsurface irrigation system caused a sharp increase in NO3-N in the drainage water. Anhydrous ammonia with or without nitrapyrin reduced NO3-N leaching losses for one to two weeks but had little effect on the average NO3-N concentration over a forty-seven day period. Subsurface irrigation stimulated turfgrass growth in bands about 20 cm wide located above the irrigation lines. Appearance of growth bands was associated with low temperatures and increased levels of NO3-N in proximity to the irrigation lines. Banding was most apparent in soil mixtures containing low levels of residual soil N and absent when turfgrass was adequately fertilized with N.

78:05B-012
NATURAL VEGETATION AS A SOURCE OF DIFFUSE SALT WITHIN THE COLORADO RIVER BASIN,
Malekuti, A., and Gifford, G.F.
Utah State University, Logan, Department of Range Science.
Water Resources Bulletin, Vol. 14, No. 1, p 195-205, February, 1978. 8 fig, 4 ref.

Descriptors: *Salts, *Colorado River Basin, *Ranges, *Vegetation, Leachate, Overland flow, Gullies, Channels, Dissolved solids, Subsurface flow.

Foliage and litter leachate from selected natural vegetation in the Price River Basin (within the Upper Colorado River Basin) was studied to determine the probable impact of plants on the amount of diffuse salt movement from rangeland watersheds. Calculations using concentrations of various leachates and characteristics of range sites expected to be high salt producers indicated that plants contribute between 0.01 and 0.02% or less of the total annual salt load to the Price River. Therefore, it was concluded that plants are not a significant source of diffuse salt within the Colorado River Basin.

78:05B-013
LINE SOURCE DISPERSION WITH APPLICATION TO MIXING IN RIVER CHANNELS,
Shen, H.T.
Clarkson College of Technology, Potsdam, New York, Department of Civil and Environmental Engineering.
Water Resources Bulletin, Vol. 14, No. 1, p 35-45, February, 1978. 4 fig, 22 ref.

Descriptors: *Dispersion, *Solutes, *Rivers, *Model studies, *Path of pollutants, Channel flow, Lime, Mixing, Uniform flow, Hydraulics.

Two-dimensional solutions for transient dispersion of nonconservative dispersants in uniform flow resulting from a transverse line source of variable concentration were obtained using multiple integral transformations. In general, the solutions were in integral forms, which can be evaluated efficiently using Filon's quadratures. Examples were presented for cases of practical interest. Applicability of the solution for modeling dispersion in natural river channel where the distribution of flows across the channel is nonuniform was discussed.

78:05B-014
ASSESSMENT OF METHODS FOR COMPUTING STORM RUNOFF LOADS,
Wu, J.S., and Ahlert, R.C.
Rutgers University, Piscataway, New Jersey, Department of Chemical and Biochemical Engineering.
Water Resources Bulletin, Vol. 14, No. 2, p 429-439, April, 1978. 1 fig, 1 tab, 21 ref.

Descriptors: *Storm runoff, *Water pollution sources, *Model studies, Mathematical models, Evaluation, Land use, Water quality, Path of pollutants, Runoff, Computer models.

Nonpoint source pollution has been characterized, in magnitude and in concentrations of pollutants, by intermittent and impulse-type discharges into receiving waters, causing shockloading problems for the ecosystems of these water bodies. The quality of storm runoff appears random and complex in nature. There are not yet universally applicable assessment tools for analysis and evaluation of the impacts and contributions of pollutant loads to receiving waters. This paper reviewed and recommended methods for predicting storm runoff loads. The state-of-the-art for storm runoff pollution prediction includes: zero-order, direct, statistical, and descriptive methods. For transient water quality analysis of individual storm events, it is essential to have an efficient sampling program for data collection and a technically sounded method of data analysis. Intensive sampling is considered necessary to a detailed time history of runoff flows and loadings within a storm and for a limited number of storms. Homogeneous-land-use and statistical-synthetic approaches are recommended as accurate and practical methods for storm-runoff-load prediction. These two approaches are event-oriented, predicting time-varying runoff loads for transient water quality analysis, utilizing data collected from intensive sampling programs.

78:05B-015
MODEL FOR SHORT-ATTACHED THERMAL PLUMES IN RIVERS,
Paily, P.P., and Sayre, W.W.
NALCO Environmental Sciences, Northbrook, Illinois.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY5, Proceedings Paper 13762, p 709-723, May, 1978. 8 fig, 1 tab, 18 ref, 2 append.

Descriptors: *Thermal pollution, *Rivers, *Powerplants, *Missouri river, Model studies, Mathematical models, Turbulence, Heated water, Temperature, Mixing.

Side discharges of power plants thermal effluents into natural rivers cause the formation of thermal plumes, the shape and orientation of which depend upon both the discharge conditions and the ambient flow characteristics. When the turbulence level of the ambient flow is high, rapid vertical mixing is achieved between the effluent discharge and the river flow, and the thermal plume becomes shore-attached with the maximum temperatures within the plume occurring along the near shore. In order to determine the isotherm patterns within shore-attached thermal plumes, a solution of the depth-integrated steady-state convection-diffusion equation was obtained. The solution was cast in terms of space-cumulative discharge coordinates, thus allowing the inclusion of the effects of cross-channel flow induced by channel curvature in the model.

78:05B-016
TWO-DIMENSIONAL PLUME IN UNIFORM GROUNDWATER FLOW,
Wilson, J.L., and Miller, P.J.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY4, Proceedings Paper 13665, p 503-514, April, 1978. 6 fig, 17 ref, 3 append.

Descriptors: *Groundwater, *Dispersion, *Water pollution, *New York, Model studies, Mathematical models, Adsorption, Path of pollutants, Wells, Groundwater movement.

A simple analytical model of a two-dimensional plume of groundwater pollution was developed and applied to the study of hexavalent chromium contamination of Long Island, New York. The model was based on a depth-averaged mass transport equation accounting for convection, dispersion, linear equilibrium adsorption, and decay, and was applicable to the study of pollution migration from point sources in shallow groundwater aquifers. The pollutant concentration description was based on a depth-averaged mass transport equation accounting for convection, dispersion, linear equilibrium adsorption, and decay, and was applicable to the study of pollution migration from point sources in shallow groundwater aquifers. The pollutant concentration description was based on an asymptotic solution to Hantush's well function for a leaky aquifer and was accurate in the far field downstream of the source. The model results were easily visualized and evaluated when plotted as contour lines of equal concentration using a simple graphical procedure, making it convenient to examine the development of the plume over time and to evaluate the sensitivity of the plume to parameters.

78:05B-017
DISPERSIVE SOURCES IN UNIFORM GROUNDWATER FLOW,
Hunt, B.
Canterbury University, Christchurch, New Zealand, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY1, Proceedings Paper 13467, p 75-85, January, 1978. 2 fig, 9 ref, 3 append.

Descriptors: *Dispersion, *Groundwater, *Uniform flow, *Water pollution sources, Water resources, Steady flow, Groundwater movement, Model studies, Mathematical models, Equations.

Solutions were given for instantaneous, continuous, and steady-state sources of pollution in uniform groundwater flow. Then the solutions were used to determine how long a continuous source must be in place before steady-state conditions are approached, to determine the effect of a finite aquifer depth upon solutions for an infinite aquifer depth, to calculate maximum concentrations for instantaneous sources, and to determine the time required for solutions for a point source and a source of finite size to approach each other.

78:05B-018
SIMULATION OF NITROGEN MOVEMENT, TRANSFORMATIONS, AND PLANT UPTAKE IN THE ROOT ZONE,
Davidson, J.M., Rao, P.S.C., and Selim, H.M.
Florida University, Gainesville, Department of Soil Science.
In: Proceedings of National Conference on Irrigation Return Flow Quality Management, Colorado State University, Fort Collins, Colorado, p 9-18, May 16-18, 1977. 7 fig, 1 tab, 28 ref.

Descriptors: *Simulation analysis, Model studies, Nitrogen, Soil water, Soil water movement, Irrigation, Nitrification, Denitrification, Mineralization.

Two simulation models, a detailed research-type and a conceptual management-type, for describing the fate of nitrogen in the plant root zone are discussed. Processes considered in both models were: one-dimensional transport of water and water-soluble N-species as a result of irrigation/rainfall events, microbiological N-transformations and uptake of water and nitrogen species by a growing crop. The research-type model involves a finite-difference approximation (explicit-implicit) of the partial differential equations describing one-dimensional water flow and convective-dispersive NH4 and NO3 transport, along with simultaneous plant uptake and microbiological N-transformations. Ion-exchange (adsorption-desorption) of NH4 was also considered. The microbiological transformation incorporated into the model describe nitrification, denitrification, mineralization and immobilization. All transformation processes were assumed to be first-order kinetic processes. The numerical solution was flexibile in its soil surface boundary conditions, as well as initial conditions for soil water content and nitrogen concentration distributions in the soil profile. The solution can also be used for nonhomogeneous or multilayered soil systems. The research-type model involves a detailed description of the individual process and requires a large number of input parameters, most of which are frequently unavailable. Because of this, a more simple management-type model was developed. Several simplifying assumptions were introduced into the management model. This model requires a minimal amount of input data by the user, and provides a gross description of the behavior of various nitrogen species in the plant root zone.

78:05B-019
TRANSPORT OF MICROORGANISMS IN SAND COLUMNS,
Wollum, A.G., II, and Cassel, D.K.
North Carolina State University, Raleigh, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 1, p 72-76, January-February, 1978. 6 fig, 5 tab, 8 ref.

Descriptors: Micoorganisms, Saturated flow, Wastes, Sewage effluents, Bacteria.

Transport of streptomycete conidia through saturated columns of uniformly packed sand was studied using miscible displacement techniques. Autoclaved sand was uniformly packed to give sand columns 20.3 and 152 cm high. Mean pore water velocities ranged from 14.4 to 131 cm/hour. A pulse of sterile water containing from 10000 to 1000000 conidia and tagged with 36Cl was displaced through each column with sterile water. Column effluent was collected and analyzed for conidia by serial dilution techniques utilizing starch-casein agar. At the termination of each run, the column was sampled and analyzed for conidia distribution.

78:05B-020
A CASE STUDY-NITRATES IN THE UPPER SANTA ANA RIVER BASIN IN RELATION TO GROUNDWATER POLLUTION,
Ayers, R.S.
California University, Davis, Department of Land, Air and Water Resources.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 355-367, May 15-18, 1978. 2 fig, 1 tab, 4 ref.

Descriptors: Nitrates, Nitrogen, Water managment (applied), Fertilization, Waste disposal, Pollutant identification.

In response to a request from the Santa Ana Watershed Planning Agency (a regional planning agency) the Kearney Foundation of Soil Science of the University of California conducted an interdisciplinary three-month study of the nitrate problem in the Basin. The study was limited to the upper part of the basin where nitrate degradation of waters was more serious. The study included 1) a review of available data to identify existing areas of high nitrate concentrations in underground waters, 2) a review of past land use, water and fertilizer use and waste disposal practices, and 3) estimates of the impact of irrigation, fertilization and use of animal wastes on leaching of nitrate from root zones. Guidelines for the use of water, fertilizers and manures were developed.

78:05B-021
ESTIMATING THE INFLUENCE OF SOIL RESIDENCE TIME ON EFFLUENT WATER QUALITY,
Jury, W.A.
California University, Riverside, Department of Soil and Environmental Sciences.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 265-290, May 15-18, 1978. 6 fig, 1 tab, 30 ref, 12 equ.

Descriptors: Effluents, Water quality, Travel time, Drainage, Tile drainage, Nitrates.

Models are proposed to calculate the time required for dissolved chemicals to move from the soil surface to either underlying groundwater in the case of free drainage or to tile drain outlets in the case of artificial drainage. The models assume that dissolved substances are transported primarily by moving soil solution, which displaces soil water initially present in the wetted pore space (piston flow approximation). For free drainage, this results in a single travel time equation which is a function of soil water content and drainage volume. For tile drainage, the travel time depends also on the surface entry point, which is illustrated with a graph showing residence time as a function of place or origin. This graph may be used for all tile drain systems. Calculations are presented to show the influence of travel time on drainage concentrations, illustrating also how tile drain concentrations are a mixture of contributions from different parts of the field arriving at different times. Field studies of salt movement are analyzed and compared to the model predictions, with differences explained on the basis of soil variability or stagnant water in part of the wetted pore space.

78:05B-022
"BEST MANAGEMENT PRACTICES" FOR SALINITY CONTROL IN GRAND VALLEY,
Walker, W.R., Skogerboe, G.V., and Evans, R.G.
Colorado State University, Fort Collins, Colorado, Department of Agricultural and Chemical Engineering.
Publication No. EPA-600/2-78-162, July, 1978. 113 p, 21 fig, 11 tab, 46 ref.

Descriptors: Irrigation, Fluid infiltration, Salinity, Seepage, Water distribution, Water loss, Water pollution, Water quality, Sprinkler irrigation.

A nontechnical summary of several research activities in the Grand Valley is given. Analyses of alternative measures of reducing the salt load originating from the Valley as a result of irrigation return flows are presented. These alternatives include conveyance channel linings, field relief drainage, on-farm improvements (such as irrigation scheduling, head ditch linings, sprinkler and trickle irrigation), economic control measures such as taxation and land retirement, modified legal constraints, and collection and treatment of return flows with desalting systems. The best management practices for salinity control in the Grand Valley should be primarily the structural rehabilitation and operational modification of the local irrigation system lying below the turnouts from the major canal systems. Canal linings appear in the optimal strategies at higher levels of valley-wide salinity control emphasis but only so far as lining the Government Highline Canal is concerned. Desalting would become a cost-effective alternative after major irrigation system improvements are implemented.

78:05B-023
LOSS OF SPRAY AND PELLETED PICLORAM IN SURFACE RUNOFF WATER,
Bovey, R.W., Richardson, C., Burnett, E., Merkle, M.G., and Meyer, R.E.
Agricultural Research Service, College Station, Texas.
Journal of Environmental Quality, Vol. 7, No. 2, p 178-180, April-June, 1978.
3 tab, 9 ref.

Descriptors: *Texas, *Herbicides, *Agricultural runoff, *Weed control, *Pesticide residues, *Surface runoff, Watersheds (basins), Rainfall, Precipitation (atmospheric), Rainfall-runoff relationships.

This investigation was conducted to determine the concentration of picloram, applied as the pelleted formulation, in surface runoff water that may move from a treated watershed to untreated areas as a result of natural or simulated rainfall. Movement of surface and subsurface applied picloram in surface runoff water also was investigated. The potassium salt of pelleted picloram was applied at 2.24 kg/ha (acid equivalent) to a 1.3-ha rangeland watershed supporting stands of honey mesquite. Surface runoff of 1.5 cm from a 2.1 cm rain received two days after treatment contained an average of 2.8 ppm picloram. Picloram content declined rapidly and runoff water contained less than 5 ppm picloram by 2.5 mo after application. Loss of the potassium salt of picloram from grassland watersheds in surface runoff water was similar whether the picloram was applied as an aqueous spray or as a pellet. Picloram applied subsurface was lost in surface runoff water, but in lower concentrations than when applied to the soil surface.

78:05B-024
ARSENIC CONCENTRATIONS IN SURFACE RUNOFF FROM SMALL WATERSHEDS IN TEXAS,
Richardson, C.W., Price, J.D., and Burnett, E.
Agricultural Research Service, Temple, Texas.
Journal of Environmental Quality, Vol. 7, No. 2, p 189-192, April-June, 1978.
1 fig, 5 tab, 10 ref.

Descriptors: *Arsenicals (pesticides), *Cotton, *Texas, *Desiccants, Arsenic compounds, Water quality, Pesticides, Surface runoff, Soil contamination.

This study was conducted to determine the movement of arsenic by surface runoff after application of arsenic acid for desiccation of cotton. Arsenic acid was applied at 6.6 kg/ha during the cotton year of a cotton-grain sorghum-oats rotation. The concentration of arsenic dissolved in the runoff water was highest during the first runoff event after application and decreased during subsequent events. Arsenic concentrations in the first runoff after treatment ranged from 250 to 18 ppb, depending on time and tillage after application. Tillage that incorporated treated plant material into the soil reduced arsenic concentration in runoff water. After two or three runoff events, the arsenic concentration decreased to 10 to 20 ppb and remained essentially constant until the next application three years later. The arsenic concentration of the sediment from the watersheds averaged 20 ppm and appeared to be related more to the arsenic content of the soil than to the length of time or the tillage between arsenic acid application and first runoff. Assuming average annual runoff and sediment yield, the amount of arsenic that would be transported from a watershed by runoff and erosion is about 7% of the amount applied. Part of the arsenic that moves from a watershed may be arsenic that occurs naturally in the soil. Of the total arsenic moved by a watershed, 38% would be in solution and 62% would be attached to the sediment.

78:05B-025
DISPOSITION OF 15N-LABELED FERTILIZER NITRATE APPLIED DURING CORN CULTURE IN FIELD LYSIMETERS,
Chichester, F.W., and Smith, S.J.
Grassland-Forage Research Center, Temple, Texas.
Journal of Environmental Quality, Vol. 7, No. 2, p 227-233, April-June, 1978.
3 fig, 5 tab, 21 ref.

Descriptors: Nitrates, Fertilizers, Water quality, Denitrification, Leachate, Runoff, Nitrogen cycle, Lysimeters, Sweet corn, Ohio.

Calcium nitrate labeled with 5.5% 15N was applied at 336 kg/ha nitrogen (N) to each of two conventional tillage and two mulch minimum tillage field lysimeters continuously cropped to corn (Zea mays L.). Disposition of the labeled N was followed for three years, particularly relative to its effect on water quality. An accounting of applied 15N for the study period showed that < 2% moved in runoff, approximately 30% was leached in percolate, 25 to 30% was recovered by the corn crop, and from 10 to 30% remained in the soil. On the basis of a balance sheet constructed from the data, 15N gaseous loss (presumably mainly by denitrification) was estimated to range from 6 to 26% of that applied. The magnitude of gaseous loss of N appeared to vary as a function of lysimeter management history, with the systems under improved soil fertility management exhibiting less gaseous loss due to greater immobilization of 15N in the soil organic fraction.

78:05B-026

PERSISTENCE OF TEBUTHIURON IN SURFACE RUNOFF WATER, SOIL, AND VEGETATION IN THE TEXAS BLACKLANDS PRAIRIE,

Bovey, R.W., Burnett, E., Meyer, R.E., Richardson, C., and Loh, A.
Agricultural Research Service, College Station, Texas.
Journal of Environmental Quality, Vol. 7, No. 2, p 233-236, April-June, 1978.
5 tab, 12 ref.

Descriptors: *Herbicides, *Agricultural chemicals, Water quality, *Texas, Urea pesticides, *Agricultural runoff, Leaching, Soil contamination, Water pollution sources, Persistence.

The concentration of tebuthiuron herbicide applied in the spray or pellet form was measured in surface runoff water from watersheds which received natural or simulated rainfall. The persistence of tebuthiuron in soil and vegetation was also investigated. Pelleted tebuthiuron was applied at 2.24 kg/ha (active ingredient) to a 1.3-ha rangeland watershed. A 2.8-cm rain, two days after application, produced 0.94 cm runoff which contained an average of 2.2 ppm of tebuthiuron. Tebuthiuron concentration decreased rapidly with each subsequent runoff event and after 3 mo was less than 0.05 ppm; none was detected in runoff water one year after treatment. The concentration of tebuthiuron, applied as a spray at 1.12 kg/ha, decreased to less than 0.01 ppm within 4 mo in runoff from a small plot which received simulated rainfall. On 0.6-ha plots, mean tebuthiuron (sprays and granules) concentration was 0.50 ppm or less in water when the first runoff event occurred 2 mo after application. Concentrations of tebuthiuron in soil and grass from pellet applications were lost (less than 1 ppm) and decreased with time.

78:05B-027

THE EFFECT OF HIGH 2,4-D CONCENTRATIONS ON DEGRADATION AND CARBON DIOXIDE EVOLUTION IN SOILS,

Ou, L-T. Rothwell, D.F., Wheeler, W.B., and Davidson, J.M.
Florida University, Gainesville, Department of Soil Science and Food Science.
Journal of Environmental Quality, Vol. 7, No. 2, p 241-246, April-June, 1978.
6 fig, 6 tab, 13 ref.

Descriptors: Pesticides, Herbicides, Pesticide residues, Persistence, Microbial degradation, Pesticide toxicity, Carbon dioxide, Waste disposal.

A laboratory experiment was conducted to determine the degradation of high concentrations of 2,4-D (2,4-dichlorophenoxyacetic acid) and CO2 evolution in three soils. Two forms of 2,4-D technical grade and formulated, were added to each soil at rates of 50, 500, 5,000 and 20,000 micrograms/g of soil (ppm). Degradation of the 2,4-D was measured by 14CO2 evolution resulting from the oxidation of uniformly ring-labeled carbon. At an application rate of 500 ppm, all three soils degraded 2,4-D. At 5,000 and 20,000 ppm, degradation occurred in the Webster silty clay loam and Terra Ceia organic soil, but not in the Cecil sandy loam during 80 days of incubation. The degradation rate was generally higher for the formulated 2,4-D than the technical grade material. For the higher 2,4-D concentrations, 5,000 or 20,000 ppm, when extensive degradation occurred, total CO2 evolution was also greatly stimulated, and the pattern of total CO2 evolution rate exhibited a two-peak response. Carbon dioxide-carbon (CO2-C) from the first peak appeared to be mainly from the formulation materials or from the impurities and CO2-C from the second peak was mainly from 2,4-D-C.

78:05B-028

PARAQUAT SORPTION AS A FUNCTION OF PARTICLE SIZE IN NATURAL SEDIMENTS,

Karickhoff, S.W., and Brown, D.S.
Environmental Research Laboratory, Athens, Georgia 30605.
Journal of Environmental Quality, Vol. 7, No. 2, p 246-252, April-June, 1978. 1 fig, 6 tab, 13 ref, 9 equ.

Descriptors: Paraquat, Sorption, Adsorption, Particle size, Pesticides, Pollutants, Sediments, Isotherms, Cation exchange, Clay minerals.

The distribution of sorbed paraquat as a function of particle size (sand through clay) was determined on five natural sediments. Paraquat concentrations in individual size fractions varied as much as two orders of magnitude within a given sediment, showing a pronounced preference for the fine silt and clay fractions. Adsorption isotherms were measured for individual size separates on one sediment. Paraquat distributions in the whole sediment agreed well with those computed using the isotherm coefficients determined on individual size separates. Paraquat sorbs by ion exchange, and sorption partition coefficients showed a definite correlation with the cation exchange capacity (CEC) of individual size fractions. However, exchange sites in different fractions differed in their effectiveness in sorbing paraquat, with the fine silt and clay exchange sites being more effective than those of the larger separates. In pure clay suspensions (hectorite and montmorillonite), sorbed paraquat did not distribute uniformly throughout the clay particle size range. It was concluded that for highly sorbed compounds such as paraquat, conventional phase separation techniques for measuring sorption may not distinguish sorbed vs. "free" compounds.

78:05B-029
FATE OF 2, 4-D IN A NAFF SILT LOAM SOIL,
Wilson, R.G., Jr., and Cheng, H.H.
Nebraska Panhandle Station University, Scottsbluff.
Journal of Environmental Quality, Vol. 7, No. 2, p 281-286, April-June, 1978.
3 fig, 4 tab, 16 ref.

Descriptors: Adsorption, Hydrolysis, Chemical degradation, Microbial degradation, Weed control, Pesticides, Runoff.

Laboratory studies were conducted to determine the adsorption, desorption, hydrolysis, and breakdown of commercially formulated isooctyl ester and dimethylamine salt of (2,4-dichlorophenoxy) acetic acid (2,4-D) in a Naff silt loam soil. More 2,4-D was adsorbed to the surface soil than to soil at lower depths, and the percentage of 2,4-D adsorbed decreased as the total amount of 2,4-D present increased. Formulated 2,4-D isooctyl ester applied to moist soil underwent hydrolysis to the anionic form at a rapid rate, with >80% of the ester hydrolyzed in 72 hours. High amounts of 2,4-D in runoff (sediment and water) retarded the active degradation of carboxyl-14C 2,4-D when 2,4-D was incubated in runoff from a wheat field treated with various formulations and rates of 2,4-D. The presence of the ester formulation at the high rate of application increased the lag period before degradation of carboxyl-14C and ring-14C 2,4-D occurred in soil. However, once the active breakdown of carboxyl-14C and ring-14C 2,4-D was initiated, little difference could be detected in the degradation patterns. At the end of the 10 weeks of incubation in runoff or in soil, only 1% of the 14C-2, 4-D originally applied to the soil could be identified as 2,4-D.

78:05B-030
TRANSFORMATION AND TRANSPORT PROCESSES IN AQUATIC SYSTEMS,
Baughman, G.L.
Environmental Research Laboratory, United States Environmental Protection Agency, College Station Road, Athens, Georgia 30601.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 98-102. 25 ref, 1 equ.

Descriptors: Pesticide kinetics, Pesticide removal, Pesticides, Aquatic environment, Chemical degradation, Pollutants, Water pollution, Water pollution control, Water quality, Volatility.

Dynamics of transformation and transport are described in terms of their controlling environmental parameters. Recent advances in our ability to mathematically describe the rate and extent of microbiological, chemical, and physical processes are discussed and data are presented to illustrate interrelationships between these processes.

78:05B-031
ESTIMATION OF ORGANOCHLORINE PESTICIDE LOSS IN SURFACE RUNOFF WATERS,
Bobovnikova, Ts.I., Virchenko, E.P., Morozova, G.K., Sinitsyna, Z.A., and Cherkhanov, Yu.P.
Institute of Experimental Meteorology, Obninsk, Union of Soviet Socialist Republics.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 103-107. 1 ref, 1 equ.

Descriptors: Pesticide removal, Pesticides, Pollutants, Runoff, Water quality, Water pollution sources, Water pollution, Estimating.

Pesticide migration in water is one of the major pathways of their transport in the environment. Surface runoff water which occurs at the watershed as the result of snowmelt or rainfall causes pesticide removal from the watershed area (agricultural lands and forests) and their entering rivers and basins. Investigations in Russia showed that surface runoff from the watershed was the major source of river water pollution with pesticides. The experimental results obtained show that the loss coefficients of organochlorine pesticides--DDT and gamma-BHC--were low both at the natural watersheds and at the experimental runoff plots (tenth and hundredth fractions of percent). The gamma-BHC loss coefficient did not exceed 3.7% even when gamma-BHC was applied in the snow cover before the snowmelt, that is under the best runoff conditions.

78:05B-032
HEXACHLOROCYCLOHEXANE, METAPHOS, AND CHLOROPHOS DECOMPOSITION IN SOIL AND THEIR MIGRATION WITH THE WATERS OF SURFACE RUNOFF,
Tarasov, M.N., Korotova, L.G., Demchenko, A.S., and Brazhnikova, L.V.
Hydrochemical Institute, Novocherkassk, Union of Soviet Socialist of Republics.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 108-116. 3 fig, 2 tab, 1 equ.

Descriptors: Pesticides, Pesticide removal, Pesticide kinetics, Runoff, Pollutants, Pollution abatement, Water quality, Water pollution.

Great quantities of chemicals and among them pesticides, enter the biosphere due to intensive chemicalization of agriculture. Upon the influence of different factors the greater part of pesticides is decomposed in soil forming primary products and certain preparations are preserved in soil for a long time due to high persistency. Systematic usage of persistent pesticides and those with high cumulative properties at vast watersheds occupied by agricultural lands may result in pollution of natural waters. In order to predict pollution of natural bodies by pesticides, it is necessary to study the rate of their decomposition in different soils, migration capability as well as to obtain quantitative characteristics of their removal from agricultural lands. This paper reports the results obtained from studies of hexachlorocyclohexane (BHC), metaphors, and chlorophors decomposition in soil, their migration capability as well as the possibility of washing out by surface runoff.

78:05B-033
CERTAIN LAWS OF ORGANOCHLORINE PESTICIDE REDISTRIBUTION IN THE SOIL-WATER, SOIL-PLANT SYSTEM,
Zhdamirov, G.G., Popov, E.E., and Lapina, N.F.
Institute of Experimental Meteorology, Obninsk, Union of Soviet Socialist Republics.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 47-60. 4 fig, 3 tab, 9 ref.

Descriptors: Pesticides, Pesticide residues, Evaporation, Sorption, DDT, Environmental effects. Estimating, Persistence, Barley, Clovers.

One of the objectives of this research work was to find the simplest method of estimating organochlorine pesticide evaporation from soils, water, and surfaces. The other one was to determine the quantitative characteristics of pesticide transport into various species of plants and their distribution in aerial and root parts of plants depending on their content in soil.

78:05B-034
GENERAL LAWS OF THE MIGRATION OF PESTICIDE RESIDUES IN THE DELTA LANDSCAPE UNDER IRRIGATION,
Sokolov, M.S.
Institute of Agrochemistry and Soil Science, Puschino, Union of Soviet Socialist Republics, Academy of Sciences.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 38-46.

Descriptors: Pesticide residues, Pesticides, Pollutants, Herbicides, Surface runoff, Subsurface runoff, Self-purification, Migration, Water pollution, Sorption.

The process of migration determines diverse after effects caused by biocides and other zenobiotics (landscape-regional, regional-basin and global ones) in the biosphere. Migration can be characterized as a complex of processes of redistribution of zenobiotics (and the products of their transformation) in space and in time. In the process of redistribution a pesticide can be transformed into various products. The leftovers of the parent compound together with the products of its transformation are defined as pesticide residues. Xenobiotics are mainly transported in aquatic medium, in atmosphere and through organism migration. In the aquatic medium xenobiotics are transported in the form of a liquid runoff (true solutions of electrolytes, compounds with neutral molecules, and colloidal solutions), and in the form of a solid runoff (suspensions, sorbed substances with precolloidal particles or organo-mineral colloids). The subsurface transport of xenobiotics is carried out principally in the form of a liquid runoff. This paper reviews and analyzes investigations conducted on the aspect of migration and transport of pesticide residues through surface and subsurface runoff.

78:05B-035
BROMACIL IN LAKELAND SOIL GROUNDWATER,
Hebb, E.A., and Wheeler, W.B.
United States Department of Agriculture, Forest Service, Southeast Forest Experiment Station, Marianna, Florida 32446.
Journal of Environmental Quality, Vol. 7, No. 4, p 598-601, October-December, 1978. 1 fig, 1 tab, 21 ref.

Descriptors: Pesticides, Herbicides, Leaching, Groundwater, Water pollution, Water table, Pesticide residues, Persistence.

The objective of this study was to evaluate the probable magnitude of the problem of the leaching of pesticides into groundwater under extreme conditions: a sandy soil low in organic matter, a persistent and mobile herbicide applied at a high rate, plentiful rainfall, and a water table within 6 m. Bromacil (5-bromo-3-sec-butyl-6-methyluracil) was applied at the rate of 22 kg/ha to a Lakeland sand bearing scrub vegetation of small oaks and poor grasses. Groundwater (at depths ranging from 4.5 to 6 m) was sampled from bromacil residue at weekly intervals for two years. Residue was first found in the groundwater 3 mo after application and was highest (1.25 ppm) one month later. Thereafter, the amount declined to <0.1 ppm in about a year and <0.001 ppm in two years. Peaks in residues generally followed periods of increased rainfall by about two weeks. Residues (0.24 ppm) were still detected in the surface soil two years after application.

78:05B-036
CLOSED FORM SOLUTION FOR PESTICIDE LOSS IN RUNOFF WATER,
Steenhuis, T.S., and Walter, M.F.
Cornell University, Ithaca, New York, Department of Agricultural Engineering.
Paper No. 78-2031, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 27 p. 4 fig, 5 tab, 17 ref, 25 equ, 1 append.

Descriptors: Pesticide removal, Pesticide residues, Runoff, Erosion, Overland flow, Adsorption, Pesticides, Regression analysis.

A closed form solution for pesticide loss in overland flow is presented based on the principle that in a zone near the soil surface, mixing zone, rain, soil, and pesticides intermix. All input variables are easily measurable except the depth of the mixing zone. A depth of 0.9 cm for this zone was found by regression using pesticide runoff data reported in literature. For verification, pesticide runoff data from Southern Georgia was used and a reasonable agreement existed between observed and predicted values.

78:05B-037
NONPOINT SOURCE POLLUTION FROM COASTAL PLAIN SOILS IN DELAWARE,
Ritter, W.F., Eastburn, R.P., and Jones, J.P.
Delaware University, Newark, Department of Agricultural Engineering.
Paper No. 78-2046, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 26 p. 6 fig, 11 tab, 14 ref.

Descriptors: Nutrient removal, Runoff, Surface runoff, Return flow, Pollutants, Water pollution, Water quality, Agricultural watersheds, Rainfall, Delaware.

Nitrogen, phosphorus and organic matter were monitored on four agricultural watersheds in the Delaware Coastal Plain. Total nitrogen and total phosphorus loads in runoff and baseflow were less than the nitrogen and phosphorus loads in rainfall.

78:05B-038
SALT PICKUP BY OVERLAND FLOW IN THE PRICE RIVER BASIN, UTAH,
Ponce, S.L., and Hawkins, R.H.
Colorado State University, Fort Collins, Department of Earth Resources.
Water Resources Bulletin, Vol. 14, No. 5, p 1187-1200, October, 1978. 5 fig, 2 tab, 10 ref, 1 equ.

Descriptors: Salts, Saline soils, Salt balance, Overland flow, Shales, Salinity, Utah, Water pollution, Water quality, Colorado River Basin.

This study emphasized a field investigation of salt release to overland flow from Mancos shale lands of the Price River Basin, Utah. Although a high degree of natural variation existed in the data, which precluded the separation of factors affecting diffuse salt loading that occurs during overland flow, a simplistic nonpoint source loading function developed on empirical concepts was fit to the data. This function was then used to calculate the average annual salt yield to the Price River by overland flow. It was found that even under severe conditions, the salt yields from Mancos shale lands due to overland flow is relatively minor, accounting for less than 1.5% of the average annual salt mass transported from the basin by the Price River.

78:05B-039
CONTAMINANT TRANSPORT TO DEEP WELLS,
Weston, R.F., Phillips, K.J., and Gelhar, L.W.
Weston Incorporated, Rosyln, New York.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY6, Proceedings Paper 13824, p 807-819, June, 1978. 9 fig, 2 tab, 12 ref.

Descriptors: *Pollutants, *Water wells, *Groundwater, *Water pollution, *Groundwater movement, *Groundwater quality, Wastes, Wells, Base flow, Model studies, Soil water movement, Analytical techniques, Mathematical models, Theoretical analysis, Water quality, Nitrates, Soil contamination, Well contamination.

Described herein by analytical and numerical techniques was the process of convective transport of a conservative contaminant to a deep, partially screened pumping well overlain by a zone of contaminated water. The three-dimensional flow to the well was treated as a point sink in an anisotropic medium. The effects of a regional downward flow, a phreatic surface above the well, and an impervious lower boundary were evaluated. The theoretical results were compared with the observed mitrate contamination of wells in Long Island, New York. It was shown that the local convective transport produced due to pumping greatly accelerates the process of contamination and decontamination of the wells.

78:05B-040
QUALITY OF PERCOLATE BELOW THE ROOT ZONE OF SELECTED VEGETABLES GROWN IN NORTHERN GUAM,
Demeterio, J.L.
Guam University, Agana. Water Resources Research Center.
Completion Report PB-280 666, April, 1978, 28 p. 14 tab, 15 ref.

Descriptors: *Percolating water, *Water pollution, *Clays, *Fertilizers, *Guam, Pesticides, Vegetables, Root zone, Sevin, Diazinon, Malathion, Dibron, Farm wastes, Ammonium sulfate, Nitrogen, Phosphorus, Percolation, Potassium nitrate, Tomatoes, Cabbage, Peppers, Eggplant, Water quality.

Northern Guam farms were surveyed in 1976 and 1977 for pesticide and fertilizer usage. The major pesticides used in 1976 and 1977 were sevin, diazinon, malathion, and dibron. Kethane was widely used in 1976 but not in 1977. Animal manure, 15-15-15 and 16-16-16 were the most widely used fertilizers in 1976 and 1977. A notable increase in the use of ammonium sulfate occurred in 1977. The chance of groundwater contamination from agricultural chemicals is minimal since a very small percentage of the land area is currently being utilized for full-time farming. Bench scale lysimeter studies were conducted to determine the concentrations of nitrogen and phosphorus in percolate water after passing the root zone of selected fertilized vegetables. Tomatoes, Chinese cabbage, head cabbage, eggplant, and bell pepper were grown using ammonium sulfate, chicken manure, potassium nitrate, and 15-15-15 as fertilizers. Potassium nitrate is the best nitrogen source but is cost prohibitive and 15-15-15 percolates excessive amounts of nitrate and ammonia nitrogen. Actively growing vegetables used the nitrogen in the ammonium sulfate and chicken manure at comparable rates.

78:05B-041
ATMOSPHERIC NITROGEN AND PHOSPHORUS LOADING TO HARP LAKE, ONTARIO, CANADA,
Nicholls, K.H., and Cox, C.M.
Ontario Ministry of the Environment, Rexdale, Water Resources Branch.
Water Resources Research, Vol. 14, No. 4, p 589-592, August, 1978. 2 fig, 3 tab, 13 ref.

Descriptors: *Nitrogen, *Phosphorus, *Lakes, *Canada, *Harp Lake, Nutrients, On-site investigations, On-site data collections, Atmosphere, Water pollution sources, Precipitation (atmospheric), Rain, Snow, Trees, Pollen, Hydrogen ion concentration, Water pollution.

Nitrogen and phosphorus in precipitation and dry fallout (aeolian sources), as well as the pH of rainfall, were measured over Harp Lake in Ontario during 1974. Weighted mean concentrations of total N and total P during the ice-free period of collection were 1.91 mg N/l and 0.105 mg P/l. Winter concentrations of total N were similar, but total P concentrations were much lower, averaging 0.013 mg/l in fresh snow. Total atmospheric loading of P to the lake was 74.4 P/sq m yr, and the total N loading was 1600 mg N/sq m yr. About 52%, or 39.0 mg P/sq m yr of the total P loading from the atmosphere was total dissolved P (0.22-micrometer filtrate), and 28%, or 20.6 mg P/sq m yr, of the total P loading was dissolved reactive P ("orthophosphate" P). Dissolved inorganic N loading at 1010 mg N/sq m yr comprised about 63% of the total N loading from the atmosphere. Pollen, from a variety of trees surrounding the lake, contributed about 20% of the total P input. The pH of rainfall samples ranged from 3.2 to 5.1 with a median value of 3.9 (n = 14).

78:05B-042
EFFECT OF PH ON THE ADSORPTION OF TRACE RADIOACTIVE CESIUM BY SEDIMENTS,
Elprince, A.M.
King Faisal University, Dammam, Saudi Arabia, Department of Soil and Water.
Water Resources Research, Vol. 14, No. 4, p 696-698, August, 1978. 1 fig, 1 tab, 12 ref.

Descriptors: *Hydrogen ion concentration, *Cesium, *Adsorption, *Sediments, Trace elements, Radioactive wastes, Radioactivity, Model studies, Mathematical models, Sampling, Surveys, Laboratory tests, Water pollution, Streams, Rivers.

The adsorption of trace radioactive cesium by sediments from the Savannah River Plant area follows a theoretically expected linear relationship between ln Kd and the pH of the equilibrium solution, where Kd is the equilibrium distribution coefficient: Cs adsorbed (meq/g)/Cs(+) in solution (meq/ml). Theoretically, the slope of these plots is proportional to the fraction of surface area occupied by pH dependent charges. Experimentally, the slope becomes 0 after removal of hydroxy Al interlayers with citrate pretreatment. Thus, hydroxy Al interlayers are the main source for the pH dependent charges making Cs+ adsorption pH dependent.

78:05B-043
NITROGEN INPUTS AND LOSSES TOBACCO, BEAN, AND POTATO FIELDS IN A SANDY LOAM WATERSHED,
Cameron, D.R., DeJong, R., and Chang, C.
Agriculture Canada, Swift Current, Saskatchewan.
Journal of Environmental Quality, Vol. 7, No. 4, p 545-550, October-December, 1978.
4 fig, 1 tab, 20 ref.

Descriptors: Nitrogen removal, Leaching, Nitrates, Denitrification, Fertilization, Tobacco, Beans, Potatoes.

Results from a 2-year study concerned with additions and losses of N from cropped fields in an intensively farmed sandy loam watershed in southern Ontario indicated that heavily fertilized burley tobacco (220 kg N/ha per year) and potato (165 kg N/ha per year) fields can potentially lose up to 52 and 92 kg N/ha per year, respectively, from the 75-cm profile by leaching and denitrification. Mineral N production rates calculated from results obtained in the field over the growing season varied from 0.0 to 0.73 kg N/ha per year. The lower rate resulted from leaching losses. The monitored NO3-N profile distributions under fertilized burley tobacco and potato crops showed definite leaching patterns. Soil water samples taken periodically from the potato field at 90 and 150 cm showed NO3-N moving through the lower profile in response to rainfall events. A plot treated with Cl showed no significant Cl leaching losses until early fall when rains moved about 45% of the added Cl below 75 cm.

78:05B-044
NUTRIENT RUNOFF FROM FERTILIZED AND UNFERTILIZED FIELDS IN WESTERN CANADA,
Nicholaichuk, W., and Read, D.W.L.
Research Station, Research Branch, Agricultural Canada, Swift Canada, Saskatchewan S9H 3X2.
Journal of Environmental Quality, Vol. 7, No. 4, p 542-544, October-December, 1978.
2 tab, 13 ref.

Descriptors: Water quality, Nitrogen, Phosphorus, Sediments, Surface runoff, Fertilization, Wheat, Snowmelt, Fallowing, Canada.

Nutrient transport in surface runoff from snow was measured from fertilized and unfertilized cropped and summer fallowed Wood Mountain loam fields in semiarid southwest Saskatchewan. The amount of nitrogen lost from unfertilized fields during spring runoff exceeded the limits purported to result in algal growth; however, the loss was agronomically insignificant. It was concluded that since the N and P concentrations in runoff from unfertilized fertile agricultural soils exceed Saskatchewan Water Quality criteria, these guidelines may be regarded as unattainable under the present system of cereal cropping in western Canada.

78:05B-045
TEMPERATURE AND pH AS LIMITING FACTORS IN LOSS OF NITRATE FROM SATURATED ATLANTIC COASTAL PLAIN SOILS,
Gilliam, J.W., and Gambrell, R.P.
North Carolina State University, Raleigh, Department of Soil Science.
Journal of Environmental Quality, Vol. 7, No. 4, p 526-532, October-December, 1978. 5 fig, 2 tab, 35 ref.
(See 78:02K-048)

78:05B-046

NITROGEN AND PHOSPHORUS LOSSES FROM ORGANIC SOILS,

Duxbury, J.M., and Peverly, J.H.
Cornell University, Ithaca, New York, Department of Soil Organic Chemistry.
Journal of Environmental Quality, Vol. 7, No. 4, p 566-570, October-December, 1978. 3 fig, 2 tab, 15 ref.

Descriptors: Nutrient removal, Organic soils, Leaching, Nitrogen, Phosphorus, Runoff, Drainage water, Water quality, Fertilization, Water pollution.

The nutrient content of drainage water from Histosols located in New York was monitored from June 1975 through July 1977. Continuous flow records and nutrient concentration data obtained from daily composite samples were used to calculate annual nutrient outputs which ranged from 0.6 to 30.7 kg/ha for PO4(3-)-P, 39.2 to 87.5 kg/ha for NO3(-)-N, and <1.0 to 1.9 kg/ha for NH4(+)-N. Nutrient concentrations in the drainage water increased with increasing flow, so that the greatest output of nutrients was during late winter and spring high-flow events. Maximum observed concentrations were 35 mg/liter for NO3(-) and 10 mg/liter for PO4(3-)-P. The amount of N lost in drainage water was similar at all sites and was about 10% of that mineralized; the remainder was presumed to be denitrified. The fiftyfold variability in phosphorus output appeared to be related to interactions within the soil profile rather than fertilizer practices, although these probably contributed to the generally high levels found. It was concluded that fertilizer nitrogen additions were unlikely to affect the quantity of NO3(-) leached. The study showed that organic soils can contribute to N and P in land runoff in much greater proportions than indicated by their area.

78:05B-047

REDOX POTENTIALS IN A CROPPED POTATO PROCESSING WASTE WATER DISPOSAL FIELD WITH A DEEP WATER TABLE,

Smith, J.H., Gilbert, R.G., and Miller, J.B.
Snake River Conservation Research Center, Kimberly, Idaho 83341.
Journal of Environmental Quality, Vol. 7, No. 4, p 571-574, October-December, 1978. 2 fig, 2 tab, 9 ref.

Descriptors: Oxidation-reduction potential, Waste water (pollution), Waste water disposal, Denitrification, Nitrification, Nitrogen, Nitrates, Flood irrigation, Water pollution, Groundwater.

Redox potential measurements were made in a field irrigated with potato processing waste water at seven depths of 5 to 150 cm for 14 months. Irrigation with canal water mixed with waste water in the summer, and with waste water in the winter, decreased redox potentials in the field at some depths for a short time but not enough to cause denitrification. However, as the soil temperature increased in the spring, and decomposition of the accumulated waste organic matter accelerated, redox potentials decreased after each irrigation at all observed depths. During April, redox potentials low enough to promote denitrification (below +225 mV) at 90-, 120-, and 150-cm depths in the soil persisted for 2 weeks. Irrigation with nondiluted waste water in June and July decreased redox potentials and denitrification occurred for up to 3 days after irrigations. As the soil temperature increased in the spring, nitrification of accumulated organic matter increased soil nitrates. Waste water irrigations from April to July promoted denitrification, removing most of the nitrate from the soil, and thereby decreasing the potential for groundwater pollution.

78:05B-048

SIMAZINE RESIDUE LEVELS IN IRRIGATION WATER AFTER DITCHBANK APPLICATION FOR WEED CONTROL,

Anderson, L.W.J., Pringle, J.C., Raines, R.W., and Sisneros, D.A.
Aquatic Weed Control Research Laboratory, Science and Education Administration, Federal Research, United States Department of Agriculture, Denver, Colorado 80225.
Journal of Environmental Quality, Vol. 7, No. 4, p 574-579, October-December, 1978. 8 fig, 2 tab, 20 ref.

Descriptors: Aquatic weed control, Aquatic weeds, Herbicides, Irrigation water, Water quality, Gas chromatography.

A field study was conducted to determine the amount of simazine (2-chloro-4,6-bis (ethylamino)-s-triazine) likely to be found in irrigation water after ditchbank treatment for weed control. Resulting data are useful in evaluating the potential impact of simazine on crops irrigated from sprayed canals. Canals were selected in California, Colorado, and Washington for the application of simazine to both watered and dewatered sites at rates of 2.25 to 7.43 kg/ha. Simazine levels in flowing canal water immediately after herbicide application did not exceed 60 micrograms/liter. In first-flow samples collected in the spring from the sites that were dewatered at application, simazine levels peaked at about 250 micrograms/liter within the treated section but decreased rapidly to <5 micrograms/liter.

78:05B-049

STREAM CHEMISTRY AND WATERSHED NUTRIENT ECONOMY FOLLOWING WILDFIRE AND FERTILIZATION IN EASTERN WASHINGTON,

Tiedemann, A.R., Helvey, J.D., and Anderson, T.D.

United States Department of Agriculture Forest Service, Pacific Northwest Forest and Range Experiment Station, Forest Hydrology Laboratory, Wenatchee, Washington 98801.

Descriptors: Streams, Forest fires, Fertilization, Ureas, Ammonium compounds, Nutrients, Water quality, Nutrient removal, Washington.

During the first three years after a severe wildfire in 1970, maximum concentrations of nitrate-N (NO3-N) in stream water increased from prefire levels of <0.016 to 0.56 mg/liter on a burned, unfertilized watershed and to 0.54 and 1.47 mg/liter on two watersheds that were burned and fertilized. Maximum NO3-N concentration in stream from an unburned watershed was 0.066 mg/liter. Organic N concentrations in streamflow were nearly doubled during the second year after fire compared to prefire levels. Concentrations of total phosphorus in streams from one burned and two burned-fertilized watersheds were 1.5 to 3 times greater than from an unburned watershed. Combined concentrations of Ca, Mg, K, and Na in streams prior to fire ranged from 12.0 to 14.9 mg/liter. Concentrations declined to 7.4-10.5 mg/liter in streams from burned and burned-fertilized watersheds during the second year after fire (1972) because of dilution resulting from increased discharge and were still less in 1975 than prefire levels. Average inputs of N, P, and the four cations during the five years of study were 1.23, 0, and 3.56 kg/ha per year. Yearly N input from precipitation was sufficient to balance solution losses in three of the five post-fire years. Cation losses in solution greatly exceeded precipitation inputs in all years. Results indicate that fire and fertilization exerted negligible effects on chemical water quality for municipal use.

78:05B-050

EFFECT OF ENVIRONMENTAL FACTORS ON SURVIVAL OF SALMONELLA TYPHIMURIUM IN SOIL,

Zibilske, L.M., and Weaver, R.W.

Missouri University, Columbia, Department of Agronomy.

Journal of Environmental Quality, Vol. 7, No. 4, p 593-597, October-December, 1978. 6 tab, 18 ref.

Descriptors: Waste disposal, Pathogenic bacteria, Microorganism, Environment, Laboratory tests, Persistence.

This investigation was undertaken in the laboratory to determine how accurately salmonella survival can be predicted when environmental conditions are known. Salmonella typhimurium was inoculated into two Texas soils, a clay and a fine sandy loam, using cattle manure slurry and saline as inoculum carriers. Soil samples were incubated in the laboratory at three temperatures and moistures: 5, 22, and 39 C; and 0, 0.5, and >22 atm tension, respectively. Survival was monitored for 12 weeks by direct spread plating of soil dilutions onto dulcitol-iron thiosulfate (DIT) medium developed for this experiment. The DIT medium restricted growth of normal soil microflora but allowed growth and differentiation of S. typhimurium. Statistical evaluation of treatment effects was complex because of three factor interactions. Soil moisture and temperature interacted as did soil moisture and inoculation method. Time as a factor strongly interacted with moisture, soil, and temperature. S. typhimurium died within 1 week in dry soil incubated at 39 C, interactions occurred that resulted in survival to 42 days. Survival at 5 and 22 C was comparable and usually longer than at 39 C. Salmonella populations increased in some samples at 3 days but declined afterward.

78:05B-052
TRANSPORT OF ANTIBIOTIC-RESISTANT ESCHERICHIA COLI THROUGH WESTERN OREGON HILLSLOPE SOILS UNDER CONDITIONS OF SATURATED FLOW,
Rahe, T.M., Hagedorn, C., McCoy, E.L., and Kling, G.F.
Oregon State University, Corvallis, Department of Soil Science and Microbiology.
Journal of Environmental Quality, Vol. 7, No. 4, p 487-494, October-December, 1978. 3 fig, 3 tab, 16 ref.

Descriptors: Sewage effluents, Coliforms, Groundwater, Water pollution, Tracers, Waste disposal, Septic tanks, Sewage disposal, Perched water, Subsurface flow.

Field experiments using strains of antibiotic resistant Escherichia coli were conducted to evaluate the events which would occur when a septic-tank drainfield became submerged in a perched water table and fecal bacteria were subsequently released into the groundwater. Three separately distinguishable bacterial strains were inoculated into three horizontal lines installed in the A, B, and C horizons of two western Oregon hillslope soils. Movement was evaluated by collecting groundwater samples from rows of modified piezometers (six piezometers/row) placed at various depths and distances downslope from the injection lines. Transport of E. coli differed at both sites with respect to movement rates, zones in the soil profiles through which major translocation occurred, and the relative numbers of cells transported over time. Movement rates of at least 1,500 cm/hour were observed in the B horizon at one site. The strains of E. coli survived in large numbers in the soils examined for at least 96 hours and appeared to be satisfactory as tracers of subsurface water flow. The concept of partial displacement (or turbulent flow through macropores) was discussed as an explanation of the rapid movement of substantial numbers of microbial cells through saturated profiles.

78:05B-053
LEACHING OF CATIONS AND CHLORIDE FROM MANURE APPLIED TO AN IRRIGATED SOIL,
Pratt, P.F.
California University, Riverside, Department of Soil Science.
Journal of Environmental Quality, Vol. 7, No. 4, p 513-516, October-December, 1978. 3 fig, 15 ref, 8 equ.
(See 78:05G-042)

78:05B-054
EFFECTS OF SO2 AND NO2 ON NITRIFICATION IN SOIL,
Labeda, D.P., and Alexander, M.
Abbott Laboratories, North Chicago, Illinois 60064.
Journal of Environmental Quality, Vol. 7, No. 4, p 523-526, October-December, 1978. 4 fig, 1 tab, 24 ref.

Descriptors: Air pollution, Nitrification, Nitrates, Fumigants, Nitrites, Ecology.

Nitrification in Lima loam, pH 7.2, was not affected by continuous exposure of the soil to 0.5 ppm of SO2 or to brief exposures to higher SO2 levels. Such treatment did not increase the levels of soluble K, Mg, Ca, Mn, Fe, and Al. Intermittent exposure of Hudson silty clay loam, pH 5.0, to SO2 reduced the rate of nitrate formation. Continuous fumigation of Lima loam with 5 ppm NO2 inhibited the rate of ammonium disappearance, led to greater rates of nitrate formation, and resulted in nitrite accumulation. Nitrite at a level of 30 micrograms N/g of soil also reduced the rate of ammonium disappearance. The results demonstrated that nitrification in certain soil could be inhibited in areas acutely polluted with SO2 and NO2.

78:05B-055
ZINC AND CADMIUM CONTENTS OF AGRICULTURAL SOILS AND CORN IN NORTHWESTERN INDIANA,
Pietz, R.I., Vetter, R.J., Masarik, D., and McFee, W.W.
The Metropolitan Sanitary District of Greater Chicago, Canton, Illinois, Research and Development Laboratory.
Journal of Environmental Quality, Vol. 7, No. 3, p 381-385, July-September, 1978. 1 fig, 3 tab, 26 ref.

Descriptors: Heavy metals, Soil contamination, Environmental effects, Crop response, Pollutants, Zinc, Cadmium, Industrial plants, Urbanization, Corn (field).

Soil and corn (Zea mays L.) leaf and grain samplings were conducted in northwestern Indiana to determine if airborne heavy metal particulates containing Cd and Zn from the northwestern Indiana industrial-urban complex, situated on the south side of Lake Michigan, were contaminating soils and crops. Sampling in the region revealed no widespread metal contamination. Some metal enrichment had occurred on agricultural soils in Gary and East Gary, Indiana. Corn leaf concentrations of Cd, Pb, and Zn fluctuated with sampling location, but grain Cd and Pb levels remained essentially constant at <0.05 and <0.4 microgram/gram, respectively. A comparison of Zn/Cd ratios in soils, and in corn leaves and grain, suggested that Cd was more actively accumulated in the corn plant but not the grain. Because of the limited acreage affected and the relatively low metal levels observed, no human or animal health problems are expected from harvested crops or silage. The use of log distance vs. log metal concentration in regression analysis showed that the limited metal contamination of agricultural soils was mainly in a southeasterly direction from the industrial-urban area.

78:05B-056
PERSISTENCE AND FACTORS AFFECTING DISSIPATION OF MOLINATE UNDER FLOODED RICE CULTURE,
Deuel, L.E., Turner, F.T., Brown, K.W., and Price, J.D.
Texas A & M University, College Station, Department of Soil and Crop Science.
Journal of Environmental Quality, Vol. 7, No. 3, p 373-377, July-September, 1978. 2 fig, 5 tab, 7 ref.

Descriptors: Pesticides, Persistence, Return flow, Degradation (decomposition), Microbial degradation, Pesticide residues, Submergence, Rice, Oxidation-reduction potential, Water pollution.

Pesticides, essential for the economical production of rice (Oryza sativa L.), could pose a serious problem if transported to surface impoundments and estuaries along the Gulf Coast via the return flow associated with flooded rice culture. Field experiments were conducted under flooded rice cultivation to determine persistence and half-life of molinate (S-ethyl-hexahydro-1-H-azepine 1-lcarbothioate). Persistence and half-life were evaluated with respect to intermittent and continuous flow irrigation schemes at normal and excessive application rates of 3.4 and 11.2 kg/ha molinate, respectively. Persistence at statistically significant levels ranged from 96 to 384 hours following the application, and generally was more a function of the application rate than irrigation scheme. Half-life values averaged 96 ± 22 hours in intermittent flow plots, and 54 ± 17 hours in continuous flow plots over the 3-year experiment. Application rate had little effect on half-life. Best fit analysis of field data to the first order biological decay equation and laboratory studies under flooded soil conditions suggested that biological degradation was the principle mode by which molinate was dissipated in the field experiment.

78:05B-057
EVALUATING THE ENVIRONMENTAL CONSEQUENCES OF GROUNDWATER CONTAMINATION 1. AN OVERVIEW OF CONTAMINANT ARRIVAL DISTRIBUTIONS AS GENERAL EVALUATION REQUIREMENTS,
Nelson, R.W.
BCS Richland, Incorporated, Washington, Department of Scientific Systems.
Water Resources Research, Vol. 14, No. 3, p 409-415, June, 1978. 8 fig, 1 tab, 9 ref.

Descriptors: *Groundwater, *Water pollution, *Path of pollutants, *Environmental effects, Model studies, Mathematical models, Equations, Pollutants, Soil contamination, Groundwater movement, Water pollution sources.

The environmental consequences of subsurface contamination problems can be evaluated completely and effectively by fulfilling the following five requirements: (1) determining each present or future outflow boundary of contaminated groundwater, (2) providing the location/arrival time distributions, (3) providing the location/outflow quantity distributions, (4) providing these distributions for each individual chemical or biological constituent of environmental importance, and (5) using the arrival distribution to determine the quantity and concentration of each contaminant that will interface with the environment as time passes. The arrival distributions on which these requirements are based provide a reference point for communication among scientists and public decision makers by enabling complicated scientific analyses to be presented as simple summary relationships.

78:05B-058
EVALUATING THE ENVIRONMENTAL CONSEQUENCES OF GROUNDWATER CONTAMINATION 2. OBTAINING LOCATION/ARRIVAL TIME AND LOCATION/OUTFLOW QUANTITY DISTRIBUTIONS FOR STEADY FLOW SYSTEMS,
Nelson, R.W.
BCS Richland, Incorporated, Washington, Department of Scientific Systems.
Water Resources Research, Vol. 14, No. 3, p 416-428, June, 1978. 11 fig, 3 tab, 20 ref.

Descriptors: *Groundwater, *Water pollution, *Path of pollutants, *Model studies, Mathematical models, Environmental effects, Equations, Pollutants, Soil contamination, Groundwater movement, Water pollution sources.

A steady, two-dimensional flow system was used to demonstrate the application of location/arrival time and location/outflow quantity curves in determining the environmental consequences of groundwater contamination. The subsurface geologic and hydrologic evaluations needed to obtain the arrival results involve a sequence of four phases: system identification, new potential determination, flow system kinematics, and contaminant transport analysis. Once these phases are completed, they are summarized effectively and easily used to evaluate environmental consequences through the arrival distributions.

78:05B-059
EVALUATING THE ENVIRONMENTAL CONSEQUENCES OF GROUNDWATER CONTAMINATION 3. OBTAINING CONTAMINANT ARRIVAL DISTRIBUTIONS FOR STEADY FLOW IN HETEROGENEOUS SYSTEMS,
Nelson, R.W.
BCS Richland, Incorporated, Washington, Department of Scientific Systems.
Water Resources Research, Vol. 14, No. 3, p 429-440, June, 1978. 9 fig, 1 tab, 8 ref.

Descriptors: *Water pollution, *Groundwater resources, *Contaminant arrival distributions, Groundwater movement, Hydrology, Environmental effects, Groundwater recharge, Mathematical models, Steady flow.

The versatility of the new contaminant arrival distributions for determining environmental consequences of subsurface pollution problems is demonstrated through application to a field example involving land drainage in heterogeneous porous materials. Though the four phases of the hydrologic evaluations are complicated because of the material heterogeneity encountered in the field problem, the arrival distributions still effectively summarize the minimal amount of data required to determine the environmental implications. These arrival distributions yield a single graph or tabular set of data giving the consequences of the subsurface pollution problems. Accordingly, public control authorities would be well advised to request that the results of subsurface pollution investigations be provided in the form of arrival distributions and the resulting simpler summary curve or tabulation. Such an objective is most easily accomplished through compliance with the requirements presented by Nelson for assuring a complete subsurface evaluation.

78:05B-060
EVALUATING THE ENVIRONMENTAL CONSEQUENCES OF GROUNDWATER CONTAMINATION 4. OBTAINING AND UTILIZING CONTAMINANT ARRIVAL DISTRIBUTIONS IN TRANSIENT FLOW SYSTEMS,
Nelson, R.W.
BCS Richland, Incorporated, Washington, Department of Scientific Systems.
Water Resources Research, Vol. 14, No. 3, p 441-450, June, 1978. 10 fig, 4 tab, 4 ref.

Descriptors: *Water pollution, *Groundwater contamination, Groundwater resources, Groundwater movement, Hydrology, Environmental effects, Groundwater recharge, Mathematical models, Transient flow system.

The versatility of the new contaminant arrival distributions for determining environmental consequences of subsurface pollution problems is demonstrated through application to a transient flow system. Though some of the four phases of the hydrologic evaluations are more complicated because of the time dependence of the flow and input contaminant concentrations, the arrival distributions still effectively summarize the data required to determine the environmental implications. These arrival distributions yield two graphs or tabular sets of data giving the consequences of the subsurface pollution problems in a simple and direct form. Accordingly, the public control authorities would be able to use these results to choose alternatives or to initiate corrective actions, depending on the indicated environmental consequences.

78:05B-061
PREDICTIONS OF HEAT AND MASS TRANSFER IN OPEN CHANNELS,
Rastogi, A.K., and Rodi, W.
Karlsruhe University, West Germany.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY3, Proceedings Paper 13639, p 397-420, March, 1978. 6 fig, 24 ref, 2 append.

Descriptors: *Mass transfer, *Heat transfer, *Open channels, *Model studies, Effluents, Turbulence, Dispersion, Cooling water, Buoyancy, Fluid flow, Froude number.

The paper described a three-dimensional model for calculating the distribution of velocity, temperature, and pollutant concentration in open channel flows, and a depth-averaged two-dimensional version for situations with insignificant stratification and secondary currents. Both models were restricted to parabolic flows, where influences cannot be transmitted upstream. The turbulent stresses and heat concentration fluxes appearing in these equations were determined from the so-called k-epsilon turbulence model that solves differential transport equations for the turbulence kinetic energy k and the rate of its dissipation epsilon. In the depth-averaged model, the bottom shear stress surface heat flux and turbulence production due to bottom shear stress are accounted for by source/sink terms in the relevant equations. The 3D calculations compared favorably with available measurements. The 2D and 3D predictions agreed well for high Froude numbers; for a Froude number of 5 they agreed only for the rough bed, while for the smooth bed they start to deviate significantly at a Froude number of 10.

78:05B-062
CASING DEPTHS AND SOLUTE TRAVEL TIMES TO WELLS,
Kirkham, D., and Sotres, M.O.
Iowa State University, Ames, Department of Agronomy.
Water Resources Research, Vol. 14, No. 2, p 237-243, April, 1978. 7 fig, 9 ref.

Descriptors: *Travel time, *Solutes, *Well casings, Flow nets, Flow rates, Water pollution sources, Water wells, Aquifers, Path of pollutants.

Partially-penetrating well casing may offer some protection against chemical solutes such as nitrates and acids from agriculture industry, strip mines, sanitary landfills or other pollution sources near wells. Travel times for solutes depend on the well and aquifer geometric factors such as well and aquifer geometric factors such as well radius, screened length of the well, and thickness of the aquifer. The longest and shortest travel times and flow nets were computed for 18 well-aquifer geometries assuming piston flow in a steady state along streamlines in a phreatic (water-table) aquifer and a fixed radius of influence. Dimensionless travel time t', increases as the impervious well casing length increases. Multiplication of t' by a factor (p/KH) times b squared gives the real travel time, where f is aquifer porosity, K is conductivity, H is the difference in head between the water table level and the level in the pumped-down well, and b is the radius of influence. These travel times should be useful in well design and protection from solutes. Curves of t' versus $4/b$, where r is horizontal distance from the well center to a point on top of the aquifer were given for a number of geometries.

78:05B-063
PHOSPHORUS--A POTENTIAL NONPOINT SOURCE POLLUTION PROBLEM IN THE LAND AREAS RECEIVING LONG-TERM APPLICATION OF WASTES,
Reddy, K.R., Khaleel, R., Overcash, M.R., and Westerman, P.W.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 193-211. 7 fig, 7 tab, 29 ref, 3 equ.
(See 78:05A-017)

78:05B-064
THE FATE OF NITRATE IN SMALL STREAMS AND ITS MANAGEMENT IMPLICATIONS,
Robinson, J.B., Whiteley, H.R., Stammers, W., Kaushik, N.K., and Sain, P.
Guelph University, Guelph, Ontario, Canada, Department of Environmental Biology.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 247-259. 6 fig, 2 tab, 20 ref.

Descriptors: Nitrates, Nitrogen, Water pollution, Water quality, Nitrogen cycle, Streams, Laboratory tests, Management, Denitrification, Nutrient removal.

The present paper is a continuation of earlier investigations conducted by the authors on nitrogen transformations in stream-sediment-water systems. This paper provides further evidence for significant amounts of nitrogen loss during transport in streams and indicates the stream management options which should enhance the process.

78:05B-065
AN APPROACH TO WATER RESOURCES EVALUATION OF NONPOINT SOURCES FROM SILVICULTURAL ACTIVITIES--A PROCEDURAL HANDBOOK,
Currier, J.B., Siverts, L.E., and Maloney, R.C.
Watershed Systems Development Group, United States Department of Agriculture--Forest Service, Fort Collins, Colorado.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 271-280. 1 fig, 1 ref.

Descriptors: Water pollution control, Water pollution sources, Forest watersheds, Forest management, Soil erosion, Streamflow, Sediment discharge, Dissolved oxygen, Methodology.

This handbook provided an analysis methodology that can be used to describe and evaluate the changes to the water resource due to nonpoint sources from silvicultural activities. It covered only the pollutant generation and transport processes and did not consider the economic, social and political aspects of pollution control. It provided quantitative techniques for estimating potential changes in streamflow, surface erosion, mass wasting, total potential sediment discharge, and temperature. Qualitative discussions of the impacts of silvicultural activities on dissolved oxygen, organic matter, nutrients, and introduced chemicals were also included. A control section provided a list of demonstrated effective control practices and a methodology to be used to select mixtures of these controls for the prevention and mitigation of water resource impacts. Such mixtures are the technical basis for formulating "Best Management Practices" (BMP's). Because economic, social, and political analyses were not discussed in this chapter, the resulting mixtures of controls are not BMP's.

78:05B-067
NONPOINT SOURCES: STATE-OF-THE-ART OVERVIEW,
Sweeten, J.M., and Reddell, D.L.
Texas A and M University, College Station.
Transactions of the American Society of Agricultural Engineers, Vol. 21, No. 3, p 474-483, May-June, 1978. 3 fig, 2 tab, 62 ref.

Descriptors: *Water pollution sources, *Pollutants, *Nonpoint pollution sources, Agriculture, Nutrients, Nitrogen, Biochemical oxygen demand, Chemical oxygen demand, Farm wastes, Water pollution.

During the past few years, the term nonpoint pollution source has become exceedingly important to agriculture. In 1972, Federal legislation (Public Law 92-500) was passed bringing many forms of agriculturally related nonpoint pollution under regulatory authority. Section 208 of Public Law 92-500 created a cooperative local/state/Federal system for areawide water quality planning. Nonpoint pollution sources are a major concern to these Section 208 planners. During the past, both basic and applied research have been conducted on such classical soil and water conservation topics as erosion control, sediment transport, soil chemistry and physics, crop production, range management, agricultural chemicals, animal science, and forestry. The challenge today is to locate, interpret, and compile this past knowledge into forms useful for Section 208 planners. This paper reviewed the current knowledge concerning the occurrence of nonpoint pollution sources such as sediment, nutrients, pesticides, and fecal contaminants. Sediment transport equations were reviewed and described, and the pollution potential of range and pasture livestock production was discussed.

78:05B-068
SEDIMENT AND NUTRIENT CONTRIBUTIONS TO THE MAUMEE RIVER FROM AN AGRICULTURAL WATERSHED,
Nelson, D.W., Monke, E.J., Bottcher, A.D., and Sommers, L.E.
Purdue University, West Lafayette, Indiana, Department of Agronomy.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 491-505. 1 fig, 9 tab, 8 ref.

Descriptors: Sediment discharge, Sediment load, Nutrient removal, Agricultural watersheds, Agricultural runoff, Sediment transport, Water pollution, Water quality, Water pollution sources, Indiana.

Total amounts of water, sediment, and nutrients discharged from two subwatersheds of the Black Creek study area (5000 ha) Allen County, Indiana, were determined during 1975 and 1976. Above average precipitation was experienced during 1975, whereas 1976 was unusually dry. From 400 to 3700 kg of sediment/ha/yr was lost from the subwatersheds; land slope being the dominant factor in soil loss during the wet year and land use being the primary factor in drier year. Most of the total P transported was sediment-bound P, whereas a substantial proportion to total N in discharge water was nitrate. A few large rainfall events contributed to the transport of a high proportion of sediment and sediment-bound nutrients; whereas snow melt runoff accounted for disproportionally high transport of soluble nutrients. Surface runoff was the major source of sediment, sediment-bound nutrients, ammonium N and soluble organic N and P transported from the subwatersheds. A substantial proportion of soluble inorganic P was derived from septic tank effluent in one subwatershed. The relationship between fertility practices in the subwatersheds and quality of water being discharged was discussed. It was concluded that the effects of agricultural nonpoint source pollution and point source pollution on our water resources are sufficiently different that direct comparisons between them cannot be made.

SECTION XXII

WATER QUALITY MANAGEMENT AND PROTECTION

EFFECTS OF POLLUTION (GROUP 05C)

78:05C-001
EFFECTS OF EVAPORATIVE SALT WATER COOLING TOWERS ON SALT DRIFT AND SALT DEPOSITION ON SURROUNDING SOILS,
Wiedenfeld, R.P., Hossner, L.R., and McWilliams, E.L.
Texas A & M University, College Station, Texas Agricultural Experiment Station.
Journal of Environmental Quality, Vol. 7, No. 2, p 293-298, April-June, 1978.

Descriptors: Cooling towers, Saline water, Saltation, Drifting (aquatic), Environmental effects, Texas.

Five salt water cooling towers recently constructed near Galveston Bay, Texas, have been shown to contribute to salt deposition in the surrounding area. Levels as high as 1,200 kg/ha per year of total salt were encountered within 100 m of the towers, but decreased in a logrithmic fashion with distance to <300 kg/ha per year at 434 m with only 16% attributable to the cooling towers. The remaining deposition was caused by natural sea spray which varies widely but averages about 250 kg/ha per year in the study area. Changes in composition of air-borne salts with distance from the cooling towers were noted, primarily as a narrowing of the Na/Ca ratio. Salinity levels in the soil are in equilibrium with naturally deposited salts. Enhanced salt deposition levels due to the cooling towers initially caused only slight effects in the soils closest to the towers, but may eventually lead to both salinization and solonization in the surrounding vicinity.

78:05C-002
ON THE ESTIMATION OF THE ANTHROPOGENIC POLLUTION EFFECT ON THE FUNCTION STATE OF THE SOIL MICROFLORA,
Gaponyuk, E.I., and Kobzev, V.A.
Institute of Experimental Meteorology, Obninsk, Union of Soviet Socialist Republics.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 86-97. 2 fig, 2 tab, 13 ref.

Descriptors: Industrial wastes, Agricultural chemicals, Pesticides, Pesticide toxicity, Environmental effects, Pollutants, Soil microorganism, Soil microbiology, Estimating.

Experiments were conducted in Russia to estimate the anthropogenic pollution effect on the functional state of the soil microflora. The dehydrogenase activity was chosen as a criterion for evaluating the effect of industrial and agricultural toxicants on the biological activity of soil microflora. The toxic effect of high concentrations of heavy metals in soils of industrial regions was found to be greater than that of pesticides. The experimental results indicate that the toxic effect of chlororganic pesticides on the soil microflora may be accounted for by the disturbance of the dehydration processes which are of energetical value for the cell. And the decrease in the dehydrogenase activity may lead to a decrease in the biotransformation processes associated with it.

78:05C-003
INHIBITION OF PHOTOSYNTHESIS AND NITROGEN FIXATION IN ALGAE BY VOLATILE NITROGEN BASES,
Mosier, A.R.
Agricultural Experiment Station, Fort Collins, Colorado.

Journal of Environmental Quality, Vol. 7, No. 2, p 237-240, 1978. 4 fig, 2 tab, 20 ref.

Descriptors: *Nitrogen fixation, *Anabaena subcylindrica, *Chlorella ellipsoidea, *Ammonia, *Photosynthesis, *Amines, Aliphatic amines, Feed lots, Acetylene reduction, Nitrogen.

Inhibitory effects of ammonia and amines on oxygen production by the green alga Chlorella ellipsoidea and the nitrogen-fixing blue-green alga Anabaena subcylindrica were studied. Objectives were to determine whether amines and ammonia affected: (1) oxygen production in the algae as in isolated plant chloroplasts, (2) the two algae differently, or (3) nitrogen fixation by A. subcylindrica. Aliphatic amines (1-5 carbons) and ammonia decreased C. ellopsoidea oxygen production by 50% at concentration of 1.2-23.5 x 10 to the minus 9th power micrograms free amine N/cell and 160 x 10 to the minus 9th power micrograms free ammonia N/cell. Amine (1-6 carbons) concentrations of 3.0-248 x 10 to the minus 9th power micrograms free amine N/cell decreased. A subcylindrica oxygen production and nitrogen fixation 50%, as estimated by the acetylene reduction technique. Reduction of A. Subcylindrica oxygen production by 50% required ammonia concentrations of 12-2510 times greater than any single amine concentration, and decrease of acetylene reduction by 50% required ammonia concentrations of 14-1220 times greater. The effect of the chemicals on C. ellipsoidea was reversible and depended on pH and free amine concentration. Algae were axenically grown in batch culture in flasks containing Knopp's solution adjusted to pH 7.2.

78:05C-004
NUTRIENT RUNOFF FROM FERTILIZED AND UNFERTILIZED FIELDS IN WESTERN CANADA,
Nicholaichuk, W., and Read, D.W.L.
Research Station, Research Branch, Agricultural Canada, Swift Current, Saskatchewan S9H 3X2.
Journal of Environmental Quality, Vol. 7, No. 4, p 542-544, October-December, 1978. 2 tab, 13 ref.
(See 78:05B-044)

78:05C-005
EFFECT OF SULFUR DIOXIDE ON ALGAE,
Wodzinski, R.S., and Alexander, M.
Ithaca College, New York, Department of Biology.
Journal of Environmental Quality, Vol. 7, No. 3, p 358-360, July-September, 1978. 2 tab, 10 ref.

Descriptors: Algae, Air pollution, Photosynthesis, Aquatic environment, Acidic soils, Air pollution effects.

Photosynthetic activity in soil of pH 7.1 was unaffected by a 10-day exposure to 0.5 ppm sulfur dioxide (SO2) in air. However, the photosynthetic activity of Anabaena flos-aquae and Chlamydomonas reinhardtii suspended in a thin layer of medium at an initial pH of 6.0 was almost totally inhibited within 24 hours by treatment with 1.0 ppm SO2 in air. The pH of the medium decreased to 5.2 or below during this period. If the decrease in pH was prevented by the addition of soil or phosphate buffer, no inhibition of photosynthesis was observed. In contrast, addition of an acidic soil to a medium of pH 4.9 offered no protection from the adverse effects of SO2. The data indicate that the decrease in pH of samples exposed to SO2 was not the sole cause of the inhibition of photosynthetic activity.

78:05C-006
HETEROTROPHIC UTILIZATION OF ORGANIC CARBON IN AQUATIC ENVIRONMENTS,
Sayler, G.S., and Gilmour, C.M.
Tennessee University, Knoxville.
Journal of Environmental Quality, Vol. 7, No. 3, p 385-391, July-September, 1978. 12 fig, 1 tab, 22 ref.

Descriptors: Eutrophication, Aquatic environment, Bacteria, Waste water, Sewage, Respiration, Biomass, Trophic level, Water pollution, Idaho.

Field and laboratory investigations were performed to determine the contribution of dissolved organic carbon (DOC) to the eutrophication process and its effect on heterotrophic bacterial activity. Results indicated growth factors or vitamin limitations occurred in some aquatic samples. Significant responses to heterogenous carbon substrates were detected at substrate concentrations commonly occurring in pristine, low DOC waters. A direct linear relationship existed between heterotrophic activity and the concentration of available DOC. Assuming no deficiency in other essential nutrients, the DOC concentration was shown to regulate the rate and net response of heterotrophic bacterial growth and activity in aquatic environments. DOC levels were found to reflect net trophic conditions unique to individual sampling locations, thereby lending itself to assays for eutrophication assessment and pollution.

78:05C-007
THE IMPACT OF BROADLY APPLIED EFFLUENT PHOSPHORUS STANDARDS ON EUTROPHICATION CONTROL,
Gakstatter, J.H., Bartsch, A.F., and Callahan, C.A.
United States Environmental Protection Agency, Corvallis Environmental Reseach Laboratory, Corvallis, Oregon 97330.
Water Resources Research, Vol. 14, No. 6, p 1155-1158, December, 1978. 1 fig, 18 ref, 1 equ.

Descriptors: Eutrophication, Sewage effluents, Effluents, Phosphorus, Municipal wastes, Sewage disposal, Model studies, Trophic level, Water quality.

The potential trophic benefits to lakes and reservoirs of a 1 mg/l and zero-discharge total phosphorus effluent standard for municipal sewage treatment plants were examined by using two phosphorus mass balance models. The analysis included 255 lakes and reservoirs receiving municipal sewage treatment plant effluents and located in the eastern half of the United States. These water bodies, their significant tributaries, and contributing effluents were sampled during the U.S. Environmental Protection Agency's National Eutrophication Survey. Improvement in trophic condition is defined as a predicted decrease of at least 25% in external phosphorus supply, which would cause the predicted in-lake total phosphorus concentration to (1) decrease from greater to less than 40 micrograms/liter but remain above 20 micrograms/liter, (2) decrease from above 20 micrograms/liter to less than 20 micrograms/liter, or (3) decrease from less than 20 micrograms/liter to a lower concentration. Using the definition stated above, the two models indicated that 18-22% of the water bodies would benefit from a 1 mg/l effluent standard. If the requirement were zero phosphorus, 28% of the water bodies would benefit.

SECTION XXIII

WATER QUALITY MANAGEMENT AND PROTECTION

WASTE TREATMENT PROCESSES (GROUP 05D)

78:05D-001
EXTRACTABILITY OF 238PU AND 242 CM FROM A CONTAMINATED SOIL AS A FUNCTION OF PH AND CERTAIN SOIL COMPONENTS: HNO3-NaOH SYSTEM,
Nishita, H., Hamilton, M., and Steen, A.J.
California University, Los Angeles, Laboratory of Nuclear Medicine and Radiation Biology.
Soil Science Society of America Journal, Vol. 42, No. 1, p 51-56, January-February, 1978. 3 fig, 3 tab, 37 ref.

Descriptors: Soil contamination, Pollutants, Radioactivity, Nitrates, Organic matter, Iron oxides, Hydrogen ion concentration, Silica, Ion exchange, Sorption.

The study involved an equilibrium batch technique using HNO3-NaOH extracting system. The influence of various soil components on 238Pu and 242Cm extractability was determined indirectly by selectively removing them from the soil. Soil organic matter, free iron oxides, and free silica, alumina, and amorphous alumino-silicates influenced the chemical extractability of 238Pu and 242Cm. The influence of these soil components depended on the pH of the soil suspension. Below pH close to 4.5, 238Pu appeared to be more strongly sorbed on the mineral fraction of the soil than 242Cm, but above pH close to 4.5, both were strongly sorbed on the mineral fraction. With the contaminated virgin soil, the 238Pu and 242Cm extractability ranged from 4.82 to 53.05% and 0.15 to 64.58% of dose, respectively, depending on the pH of the extracting solution. The lowest extractability occurred around pH 7.1 for 238Pu and in the range of pH 4.7 to 5.6 for 242Cm.

SECTION XXIV

WATER QUALITY MANAGEMENT AND PROTECTION

WATER QUALITY CONTROL (GROUP 05G)

78:05G-001
EFFECTS OF WETTING AGENTS ON WATER INFILTRATION INTO WATER-REPELLENT COAL MINE SPOILS,
Miyamoto, S.
Texas A & M University, El Paso, Research Center.
Soil Science, Vol. 125, No. 3, p 184-187, 1978. 3 tab, 9 ref.

Descriptors: *Surfactants, *Wetting, *Strip mine wastes, *Infiltration, *Sulfonates, Spoil banks, Revegetation, Ethers, Alcohols, Effects.

Improved water infiltration may enhance revegetation of water repellent coal mine spoils. Commercially available wetting agents, therefore, were studied for their effect on increasing infiltration. The tested wetting agents included linear sulfonate (anionic), alkyl polyethylene glycol ether (nonionic), and ethoxolated alcohol (nonionic) compounds. The infiltration tests were performed under greenhouse conditions for soil as well as water applied wetting agents. Results indicated that in both cases the sulfonate compound, but not necessarily the other, improves infiltration.

78:05G-002
PREVENTION OF NITRATE LEAKAGE FROM THE HULA BASIN, ISRAEL: A CASE STUDY IN WATERSHED MANAGEMENT,
Avnimelech, Y., Dasberg, S., Harpaz, A., and Levin, I.
Technion-Israel Institute of Technology, Haifa (Israel), Department of Agricultural Engineering.
Soil Science, Vol. 125, No. 4, p 233-239, April, 1978. 4 fig, 2 tab, 17 ref.

Descriptors: *Watershed management, *Nitrates, *Leakage, Leaching, Nitrification, Drainage effects, Water table, Sprinkler irrigation, Organic soils, Crops.

Drainage of the Hula basin led to the exposure of about 2,000 ha of organic soils. Corollary to a high subsidence rate, extensive nitrification and leaching of nitrates became evident, endangering the quality of the water in Lake Kinneret (Sea of Galilee). The problem is being solved by (1) improving the drainage system and reducing water flow through the basin; (2) maintaining a relatively high water table during the summer, thus minimizing the depth of the oxidized layer; (3) inducing denitrification through the use of sprinkler irrigation; and (4) selecting crops that reduce the accumulation of nitrates in the soil.

78:05G-003
MEASUREMENT OF SEDIMENT CONTROL IMPACTS ON AGRICULTURE,
Wade, J.C., and Heady, E.O.
Arizona University, Tucson, Department of Agricultural Economics.
Water Resources Research, Vol. 14, No. 1, p 1-8, February, 1978. 2 fig, 5 tab, 13 ref.

Descriptors: *Sediment control, *Water pollution control, *Agriculture, *Measurement, Optimization, Linear programming, Land use, Mathematical models, Equations, Systems analysis.

Environmental policy has been explicitly expanded in order to consider nonpoint or dispersed sources of water pollutants. This study utilizes a national agricultural model to evaluate hypothetical policies of sediment control viewing the problem as primarily a national one of agricultural land use. A sediment sector is added to the basic Center for Agricultural and Rural Development National

Water Assessment model to test the impacts of sediment control policies on the agricultural production system. Costs of alternative control policies are analyzed; these costs are defined as the additional costs to agriculture of several alternative sediment control policies. Using linear programming, the minimum cost of the minimum feasible total sediment load is determined, a single restraint imposed at the national level.

78:05G-004
PLANNING DIFFUSE POLLUTION CONTROL: AN ANALYTICAL FRAMEWORK,
Schneider, R.R.
Williams College, Williamstown, Massachusetts, Department of Economics.
Water Resources Research, Vol. 14, No. 2, p 322-336, April, 1978. 4 fig, 2 tab, 39 ref.

Descriptors: *Planning, *Water pollution control, Benefits, Costs, Analytical techniques, Agriculture, Optimum development plans, Systems analysis, Evaluation.

Determination of an optimal nonpoint pollution control strategy demands information relating to (1) costs of pollutant reduction; (2) transport of pollutants; (3) water quality impact of pollutants; and (4) the economic impact of water quality changes. This paper briefly reviews the literature in each of these areas and suggests an analytical framework useful in the development of an optimal nonpoint pollutant control strategy.

78:05G-005
OVERVIEW OF NITROGEN IN IRRIGATED AGRICULTURE,
Rauschkolb, R.S.
California University, Davis, Cooperative Extension.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 53-60, May 15-18, 1978. 3 ref.

Descriptors: Water quality, Nitrogen, Pollution abatement, Pollutant identification, Fertilization, Water management (applied), Irrigated land, Water law.

Events of the recent past have been moving agriculture rapidly towards the point where it can no longer afford the luxury of being concerned with production of food and fiber alone. One of the principle reasons for the change in attitudes has been the Federal Water Pollution Control Act Amendment of 1972, commonly referred to as Public Law 92-500. Within this law there is a section dealing with areawide planning, Section 208. Under this section each state is to develop waste water management strategies which indicate methods for control or treatment of all point and nonpoint sources of pollution within an area. Specific outputs resulting from Section 208 area-wide planning include a regulatory program to control or treat all point and nonpoint pollution sources, including in-place or accumulated pollution sources. This represents only one of the many outputs that are expected from area 208 planning, but it is one that seems to be the most important with respect to nitrogen management in irrigated agriculture.

78:05B-006
ECONOMIC IMPACTS OF CONTROLLING NITROGEN CONCENTRATION AND OTHER WATER QUALITY DETERMINANTS IN THE YAKIMA RIVER BASIN,
Pfeiffer, G.H., and Whittlesey, N.K.
North Dakota State University, Fargo, Department of Agricultural Economics.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 415-422, May 15-18, 1978. 4 fig, 4 tab, 9 ref, 2 equ.

Descriptors: Water quality, Nitrogen, Economic impact, Return flow, Pollution abatement.

The nonpoint source nature of water quality degradation caused by irrigation return flows makes control nearly impossible with traditionally effective measures, such as limitations or taxes on effluents. As a consequence, control or taxation of those inputs to production which are involved in effluent input-output relationships is a possible alternative. In the Yakima River Basin, three determinants of river water quality were identified: nitrogen concentration, river water temperature, and soil erosion by irrigation water. Among the pollution control policies considered for effectiveness, producer cost, and social cost were taxation of nitrogen fertilizer, increasing the charge for irrigation water, reduction of irrigation water rights, and restrictions on the types of irrigation systems used. Results showed that policies which affect the level of one pollutant may or may not significantly affect the levels of others. Furthermore, policies taxing or charging for inputs, such as fertilizer and irrigation water, cause a substantial reduction in producer income if acceptable water quality is to be attained. Therefore, water quality policy formulation and evaluation should consider the interactions which exist among water quality determinants and considerations of both the expected benefits of improved water quality and the level and distribution of improvement costs.

78:05G-007
SOURCES OF NITROGEN FOR CROP UTILIZATION,
Murphy, L.S.
Potash/Phosphate Institute, Manhattan, Kansas, Great Plains Director.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 61-107, May 15-18, 1978. 23 tab, 40 ref, 2 equ.

Descriptors: Nitrogen, Fertilizers, Crop production, Nitrogen fixation, Corn (field), Soybeans, Alfalfa, Symbiosis, Ammonium compounds, Irrigation water.

Nitrogen fertilization of crops is essential for maximum food production. Nitrogen from organic matter in the soil declines with continued cultivation to the point that supplemental nitrogen applications are necessary. Supplemental sources of nitrogen for crop production include symbiotically fixed nitrogen from legumes, nonsymbiotically fixed nitrogen from free-living organisms in the soil, inorganic nitrogen from lightning discharges and industrial emissions, industrially fixed nitrogen and nitrogen from various waste products. Recommendations for nitrogen applications in either dryland or irrigated agriculture are based on crop need as determined by agricultural research. Soil analysis is an important tool in determination of needs. Use of present and future recommendations will both maximize production of food and maintain environmental quality.

78:05G-008
NITROGEN FORMS AND CYCLING IN RELATION TO WATER QUALITY,
Menzel, R.G.
Water Quality Management Laboratory, Science and Education Administration, U.S. Department of Agriculture, Durant, Oklahoma 74701.

Descriptors: Water quality, Nitrogen, Nitrogen compounds, Nitrogen cycle, Nitrogen fixation, Denitrification, Eutrophication.

The intended use of water determines the significance of various forms of nitrogen in water quality. Upper limit concentrations have been recommended for several forms of nitrogen in water used for public water supplies, freshwater aquatic life, marine aquatic life, and agricultural uses. The concentrations are lowest for cyanide, and increase in the order ammonium, nitrite, and nitrate. Nevertheless, nitrate is more often of concern in water quality than are the first three forms of nitrogen. Much of the total nitrogen in surface waters occurs in particulate or dissolved organic forms. Plant growth is often excessive when the total nitrogen concentration exceeds 0.5 mg/l if other nutrients are adequately supplied and growth conditions are favorable. Nitrogen supply limits growth in many ocean areas and in a few lakes, mainly eutrophic ones. Nitrogen fixation by blue-green algae tends to correct nitrogen deficiencies. Denitrification by bacteria tends to correct excesses. These features indicate that high nitrogen concentrations may be an effect, rather than a cause, of eutrophication.

78:05G-009
EVALUATION OF IRRIGATION METHODS FOR SALINITY CONTROL IN GRAND VALLEY,
Evans, R.G., Walker, W.R., Skogerboe, G.V., and Smith, S.W.

Colorado State University, Fort Collins, Department of Agricultural and Chemical Engineering.

Descriptors: Irrigation, Salinity, Saline soils, Water quality, Water loss, Water pollution.

Irrigation return flows in the Upper Colorado River carry large salt loads as a result of contact with the saline soils and the marine derived geologic substratum. The Grand Valley of western Colorado is a major contributor to the salinity problems of the basin and is, therefore, a logical region to test the effectiveness of agricultural salinity control alternatives. This study emphasized the implementation of on-farm salinity control alternatives; primarily evaluating irrigation scheduling, furrow irrigation, sprinkler irrigation, and trickle irrigation. Border irrigation was also evaluated, but was not implemented as part of this study. The cost-effectiveness of the various on-farm alternatives in the Grand Valley is summarized and presented in this report.

78:05G-010
INTEGRATING DESALINATION AND AGRICULTURAL SALINITY CONTROL ALTERNATIVES,
Walker, W.R.
Colorado State University, Fort Collins, Department of Agricultural and Chemical Engineering.
Publication No. EPA-600/2-78-074, April, 1978. 182 p, 30 fig, 17 tab, 55 ref, 2 append.

Descriptors: Cost-effectiveness, Desalting, Optimization, Salinity, Sprinkler irrigation, Water quality.

The cost-effectiveness relationships for various agricultural and desalination alternatives for controlling salinity in irrigation return flows are developed. Selection of optimal salinity management strategies on a river basin scale is described as a problem of integrating optimal strategies with individual subbasins and irrigated valleys. Desalination systems include seven processes: (1) multi-stage distillation; (2) vertical tube evaporation in conjunction with (1); (3) a vapor compression form of (2); (4) electrodialysis; (5) reverse osmosis; (6) vacuum freezing - vapor compression; and (7) ion exchange. Agricultural salinity control alternatives include conveyance linings, irrigation scheduling, automation, sprinkler irrigation systems, and trickle irrigation systems. A case study of the Grand Valley in western Colorado is presented to demonstrate the analysis developed. Results indicate that treatments of the agricultural system are generally more cost-effective than desalting except for high levels of potential salinity control. Lateral linings and on-farm improvements are the best agricultural alternatives.

78:05G-011
IMPLEMENTATION OF AGRICULTURAL SALINITY CONTROL TECHNOLOGY IN GRAND VALLEY,
Evans, R.G., Walker, W.R., Skogerboe, G.V., and Binder, C.W.
Colorado State University, Fort Collins, Department of Agricultural and Chemical Engineering.
Publication No. EPA-600/2-78-160, July, 1978. 193 p, 62 fig, 29 tab, 46 ref.

Descriptors: Irrigation, Ditches, Irrigation canals, Salinity, Saline soils, Salt water, Seepage, Water distribution.

A summary of the results of applied research on salinity control of irrigation return flows in the Grand Valley of Colorado is presented for the period of 1969 to 1976. Salinity and economic impacts are described for the Grand Valley Salinity Control Demonstration Project which contains approximately 1,600 hectares and involves most of the local irrigation companies in the Valley. During the eight years of the demonstration project, 12.2 km of canals were lined, 26.54 km of laterals were lined, 16,400 meters of drainage tile were installed, a wide variety of on-farm improvements were constructed, and an irrigation scheduling program was implemented. On-farm improvements evaluated were solid-set sprinklers, side-roll sprinklers, drip (trickle) irrigation, furrow irrigation, and automatic cut-back furrow irrigation. The total value of the constructed improvements in the demonstration area was about $750.000. The total improvements resulted in a salt reduction of 12,300 metric tons per year reaching the Colorado River. This salt reduction results in an annual benefit to downstream water users of nearly $2,000,000. In addition, there are benefits to the local water users with increased crop yields, and to the people of Grand Valley in increased business.

78:05G-012
SOCIO-ECONOMIC AND INSTITUTIONAL FACTORS IN IRRIGATION RETURN FLOW QUALITY CONTROL VOLUME I: METHODOLOGY,
Vlachos, E.C., Huszar, P.C., Radosevich, G.E., Skogerboe, G.V., and Trock, W.
Colorado State University, Fort Collins, Colorado 80523.
Publication No. EPA-600/2-78-174a, August, 1978. 132 p, 21 fig, 10 tab, 32 ref.

Descriptors: Water law, Water rights, Irrigation, Irrigated land, Water pollution, Water quality.

The purpose of this study has been to develop an effective process for implementing technical and institutional solutions to the problem of return flow pollution. The process developed: a) defines the problem in terms of its legal, physical, economic, and social parameters; b) identifies potential solutions in relation to the parameters of the problem; c) assesses potential solutions for diverse situations; d) specifies those solutions or groups of solutions which are the most effective in reducing pollution and are implementable. This process is conceptualized in Volume I of the study. The general results of its application are further presented in three separate volumes concerning the specific case studies of Yakima Valley (Washington), Middle Rio Grande Valley (New Mexico and Texas), and Grand Valley (Colorado).

78:05G-013
SOCIO-ECONOMIC AND INSTITUTIONAL FACTORS IN IRRIGATION RETURN FLOW QUALITY CONTROL VOLUME II: YAKIMA VALLEY CASE STUDY,
Huszar, P.C., Radosevich, G.E., Skogerboe, G.V., Trock, W.L., and Vlachos, E.C.
Colorado State University, Fort Collins, Colorado 80523.
Publication No. EPA-600/2-78-174b, August, 1978. 140 p, 19 fig, 12 tab, 113 ref, 1 append.

Descriptors: Water law, Water rights, Irrigation, Irrigated land, Water pollution, Water quality.

The goal of this research project has been to develop an effective process for implementing technical and institutional solutions to the problem of irrigation return flow pollution. This report contains the findings of a case study of the Yakima Valley, Washington. The findings are reported according to the proposed process, namely: a) defining the problem in terms of its physical, legal, and economic, and social parameters; b) identifying potential solutions in relation to the key parameters of the problem; c) assessing the range of potential solutions for the specific area of concern; and d) specifying those solutions or groups of solutions which are most effective in reducing pollution and are implementable. The basic conclusions of the report are that: a) irrigation methods used in many parts of the Valley are inappropriate to the topography and soils, thus causing return flow pollution; b) neither state nor federal water quality regulations have had a significant impact on the pollution problem; c) a major cause of the problem is the underpricing of irrigation water caused by the absence of economic markets for its allocation; d) the first step in solving the problem is the creation of an economic market to allocate irrigation water; e) perception and demonstration of the problem are vital for any efforts to implement any solutions; and f) holistic thinking by farmers regarding water in the Valley and individual acknowledgment of contributions to the problem are necessary to its solution.

78:05G-014
SOCIO-ECONOMIC AND INSTITUTIONAL FACTORS IN IRRIGATION RETURN FLOW QUALITY CONTROL VOLUME III: MIDDLE RIO GRANDE VALLEY CASE STUDY,
Trock, W.L., Huszar, P.C., Radosevich, G.E., Skogerboe, G.V., and Vlachos, E.C.
Colorado State University, Fort Collins, Colorado 80523.
Publication No. EPA-600/2-78-174c, August, 1978. 137 p, 14 fig, 15 tab, 146 ref, 2 append.

Descriptors: Water law, Water rights, Irrigation, Irrigated land, Water pollution, Water quality.

Degradation of water quality as a consequence of use in irrigation in the Lower Rio Grande Valley of New Mexico is a largely unavoidable phenomenon. In this region, annual allocations of water to irrigated farms, about 2.5 acre-feet per acre, are little more than enough to produce crops. Evaporation and transpiration, occurring because of irrigation, cause concentrations of salts in return flows to be greatly increased, and the addition of these highly saline return flows to a quite limited flow of water in the Rio Grande causes the quality of the river water to be significantly reduced. It is possible to affect the quantity and quality of return flows by improvement of water transport facilities (canals, laterals and ditches) and by improved management of water on some farms. These two technical improvements can be accomplished by extension of technical assistance through existing federal and state agencies and by cost-sharing programs such as the Agricultural Conservation Program. But it is also possible to achieve improved management of water on farms by facilitating exchanges or sales of allotments among farmers who are members of irrigation districts. Such transfers ordinarily result in improved use of water, i.e., a more conservative use of water and employment of this scarce input in higher-valued uses. The consequence is some reduction in return flows and thus improvement in the quality of water in the Rio Grande River.

78:05G-015
SOCIO-ECONOMIC AND INSTITUTIONAL FACTORS IN IRRIGATION RETURN FLOW QUALITY CONTROL VOLUME IV: GRAND VALLEY CASE STUDY,
Skogerboe, G.V., Huszar, P.C., Radosevich, G.E., Trock, W.L., and Vlachos, E.C.
Colorado State University, Fort Collins, Colorado 80523.
Publication No. EPA-600/2-78-174d, August, 1978. 139 p, 17 fig, 14 tab, 39 ref, 2 append.

Descriptors: Water law, Water rights, Irrigation, Irrigated land, Water pollution, Water quality.

The Grand Valley was used as a case study area for developing an effective process for implementing technical and institutional solutions to the problem of pollution from irrigation return flows. This area is the most significant agricultural salt source in the Upper Colorado River Basin. The primary source of salinity is from the extremely saline aquifers overlying the marine deposited Mancos Shale formation. Subsurface irrigation return flows resulting from conveyance seepage losses and overirrigation of croplands dissolve salts from this formation before returning to the Colorado River. The most cost-effective technologies for reducing the salt load are a combination of lateral lining and on-farm improvements. Farmer participation in such a program is very important. Implementation will result in excess water being available for selling, renting, or leasing to water users upstream from Grand Valley.

78:05G-016
ECONOMIC IMPACT OF WATER QUALITY ON RIVER BASIN MANAGEMENT,
Helweg, O.J., and Alvarez, D.
California University, Davis, Department of Civil Engineering.
California Water Resources Center, Davis, Completion Report, Contribution 168, March, 1978. 61 p, 47 fig, 16 tab, 47 ref.

Descriptors: *Groundwater, *Irrigation, *Water quality, *Water costs, *Economic impact, *California, *San Luis River basin (California), Irrigation practices, Saline water, Pricing, Water demand, River basin management, Water pollution.

Groundwater quality degradation caused by irrigation affects as much as one-third of the irrigated area of the world. This problem is particularly insidious because the process is slow and hidden. A management tool called the Accelerated Salt Transport (ASTRAN) method has recently been proposed to help control groundwater degradation. The ASTRAN method distributes the different qualities of available irrigation water over the basin in a way that controls groundwater degradation at minimum cost. To implement the solution, the water supplier must give some irrigators poorer quality water than others. If water is sold merely by the quantity used, irrigators who receive the poor quality water will certainly object; consequently, the price of water should be determined by water quality as well as quantity. This study investigated a way to price water quality and quantity by approximating its value with a derived demand surface. This value was then used to price the optimally distributed water. The data from the San Luis River Basin in Southern California were used to test the results which are presented in a series of figures along with a detailed description of the approach used.

78:05G-017
NORTH CAROLINA 208 CASE STUDY,
Horney, L.F., Koehler, F.A., and Bliven, L.F.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Paper No. 78-2584, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 6 p. 4 ref.
(See 78:06E-009)

78:05G-018
EFFECT OF DRAINAGE SYSTEM DESIGN AND OPERATION ON NITRATE TRANSPORT,
Skaggs, R.W., and Gilliam, J.W.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Paper No. 78-2501, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 9 fig, 3 tab, 18 ref, 4 equ.

Descriptors: Water pollution, Nitrates, Water quality, Simulation analysis, Drainage effects, Drainage systems, Drainage density, Drainage water, Surface drainage, Subsurface drainage.

Simulations were conducted to predict NO3(-) movement from artificially drained soils. Effects of alternative drainage designs and operational procedures on NO3(-) outflow to drainage waters were presented.

78:05G-019
NONPOINT SOURCE CONTROL GUIDANCE, AGRICULTURAL ACTIVITIES,
Thronson, R.E.
United States Environmental Protection Agency, Washington, D.C., Water Planning Division.
NTIS/PB-280/845, EPA-440/3-78-001, February, 1978. 147 p. 40 fig, 8 tab, 101 ref, 3 append.

Descriptors: Water pollution, Water pollution control, Water quality, Water quality control, Water pollution sources, Sediment discharge, Agricultural chemicals, Salinity, Grazing, Waste disposal.

This publication presents technical and management guidance information regarding problem identification and assessment, information needs and analyses, and best management practices (BMP's) to provide state and areawide water quality management agencies and other concerned groups with assistance in the development and implementation of programs to control nonpoint sources of pollution.

78:05G-020
EFFECT OF SALINITY ON AGRICULTURE IN IRAQ,
Al-Layla, M.A.
Mosul University, Iraq, Department of Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR2, p 195-207, June, 1978. 2 fig, 3 tab, 3 ref, 1 append.

Descriptors: Salinity, Agriculture, Irrigation effects, Return flow, Drainage water, Water quality control, Water pollution, Asia.

Irrigation has progressed considerably in Iraq, but it has resulted in soil salinity thereby reducing the productivity of the agricultural lands. Land has been reclaimed by taking up drainage projects, but the discharge of the drainage water into the river has considerably increased the salinity of the river water causing deterioration in its quality. The increase in salinity of river water creates problems for irrigation and municipal uses, and therefore, the discharge of drainage water to the river must be controlled. To obtain maximum benefit from the use of land and water resources, the problems of irrigation, drainage, control of river water quality, and education of farmers must be tackled as a whole and not in parts.

78:05G-021
A RATIONAL APPROACH FOR OPTIMIZING APPLICATION RATES OF FERTILIZER NITROGEN TO REDUCE POTENTIAL NITRATE POLLUTION OF NATURAL WATERS,
Singh, B., Biswas, C.R., and Sekhon, G.S.
Punjab Agricultural University, Ludhiana 141004, India, Department of Soils.
Agriculture and Environment, Vol. 4, No. 1, p 57-64, April, 1978. 3 fig, 2 tab, 6 ref.

Descriptors: Nitrogen, Fertilizers, Nitrates, Pollutants, Pollution abatement, Water pollution control, Wheat, Sweet corn, Crop response, Leaching, Crop production.

Yield, N uptake and residual NO3(-)-N data for wheat and maize, raised in a long-term experiment, have been discussed to determine optimum rates of fertilizer N application at which yields are least affected, while unused nitrogen, which is a potential pollutant, is reduced to a permissible level. Computation of fertilizer N rates corresponding to the points of greatest economic return and permissible N loss has been described. Optimum fertilizer N rate is the smaller of the two fertilizer N rates. By assuming a loss of 60 kg N/ha or less, as environmentally permissible, it was observed that a small yield increment of maize would have to be sacrificed for the protection of the environment; whereas, for wheat, nitrogen can be applied safely up to the point of greatest economic return. Coincidence of the rainy season with the growth period of maize in the study area seems to have reduced the fertilizer N rate, corresponding to the point of permissible N loss, lower than that for greatest economic return.

78:05G-022
AGRICULTURE AND SALINITY,
Gardner, B.D., and Stewart, C.E.
Values and Choices In the Development of The Colorado River Basin, The University of Arizona Press, Tucson, Arizona, 1978, p 121-143. 7 fig, 4 tab, 14 ref.

Descriptors: Colorado River, Colorado River Basin, Return flow, Water quality act, Water quantity control, Water pollution control, Water pollution sources, Salinity, Mexican water treaty.

This paper discusses the saline return flow problems of the Colorado River due to irrigated agriculture of the Colorado River Basin.

78:05G-023
FINANCING REGIONAL DRAINAGE FACILITIES UNDER 1978 ECONOMIC CONDITIONS,
Johnston, W.R., and Beck, L.A.
Westlands Water District, P.O. Box 5222, Fresno, California 93755.
Paper No. 78-2535, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 12 p. 3 fig, 3 tab.

Descriptors: Drainage problems, Drainage, Financing, Saline water, Salinity, California, Cost-benefit analysis, Crop production, Surface drainage, Subsurface drainage.

The benefits, costs, and a recommended financial program to solve saline drainage problems on over 400,000 hectares (1,000,000 acres) of irrigated land in the San Joaquin Valley of California, USA, are discussed. The need to provide long-term financing for major drainage facilities is demonstrated.

78:05G-024
APPLICATION OF LAND TREATMENT FOR WATER QUALITY IMPROVEMENT,
Wheaton, R.Z.
Purdue University, Lafeyette, Indiana, Department of Agricultural Engineering.
Paper No. 78-2533, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 3 p.

Descriptors: Water quality control, Water quality, Land management, Control structures, Cultural control, Soil conservation, Pollution abatement, Agricultural watersheds, Small watersheds, Water law.

Application of Land Treatment measures is considered to be a means of controlling Agricultural Non-Point Pollution. Experiences gained during a demonstration project of these principles is reviewed. The problems of absolute water quality standards and monitoring for compliance of non-point pollution are discussed and alternatives suggested.

78:05G-025
AGRICULTURAL DRAINAGE PROBLEMS IN KERN COUNTY, CALIFORNIA,
Rector, M.R., and Donnan, W.W.
Kern County Water Agency, Bakersfield, California.
Paper No. 78-2532, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 15 p. 3 fig.

Descriptors: Drainage, Drainage area, Tile drainage, Crop production, Perched water, Salinity, Drilling, Water quality, Water table, California.

This paper describes procedures followed in the diagnosis, monitoring and evaluation of the drainage problem areas within Kern County, California as a case history for use by others who are facing these same problems.

78:05G-026
SUBSURFACE DRAINAGE SYSTEMS INSTALLATIONS IN ARID LANDS--THE STATE OF THE ART,
True, G.
Advanced Drainage Systems, Incorporated, Fresno, California, Department of Agricultural Engineering.
Paper No. 78-2528, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 2 p.

Descriptors: Subsurface drainage, Drainage, Installation, Arid lands, Equipment, Materials, Trenches, Grading, Maintenance, Irrigated land.

Agricultural drainage contractors are quickly adapting to new techniques and equipment that result in better and more efficient drainage systems. These relatively inexpensive drainage systems are maintaining the long-term viability of irrigated agriculture and increasing crop yields far above the value of energy and capital invested in drainage.

78:05G-027
DESIGN AND OPERATION OF GRADIENT TERRACE SYSTEMS,
Bondurant, D.T., and Laflen, J.M.
Soil Conservation Service, Des Moines, Iowa.
Paper No. 78-2520, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 7 p. 4 fig, 5 tab, 19 ref.
(See 78:02J-006)

78:05G-028
GROUNDWATER AND SALINITY IN THE GRAND VALLEY OF COLORADO,
Kruse, E.G.
United States Department of Agriculture, Science and Education Administration, Agricultural Research, Fort Collins, Colorado.

Paper No. 78-2530, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 21 p. 5 fig, 3 tab, 14 ref.

Descriptors: Salinity, Saline water, Saline soils, Salts, Groundwater, Water management (applied), Colorado, Colorado River, Colorado River Basin, Structures.

This paper describes causes and magnitudes of groundwater flows and salt loading in the Grand Valley in western Colorado. Structural measures and management practices most likely to reduce salt loading are described.

78:05G-029
PLANT NUTRIENT LOSSES FROM FOLIAR-FERTILIZED SOYBEANS,
Baker, J.L., and Laflen, J.M.
Iowa State University, Ames, Department of Agricultural Engineering.
Paper No. 78-2084, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 11 p. 5 fig, 1 tab, 4 ref.

Descriptors: Fertilization, Nutrient removal, Nutrients, Foliar application, Water quality, Runoff, Foliar, Soybeans, Simulated rainfall, Corn (field).

To determine the impact of foliar-fertilization of soybeans on runoff water quality, simulated rainfall was applied to soybeans and corn receiving no fertilizer and to soybean plots foliar-fertilized (20 kg/ha N, 2 kg/ha P) 39 and 13 hr before rainfall. Washoff water from plants and surface runoff water were analyzed for NH4-N, NO3-N, total N, PO4-P, and hydrolyzable-P. Foliar-fertilization did initially increase concentrations of dissolved nutrients in runoff, but most N and P washed from plants was retained by the soil within plot areas.

78:05G-030
TRANSPORT CHARACTERISTICS OF PHOSPHORUS IN CHANNELIZED AND MEANDERING STREAMS,
Rosendahl, P.C., and Waite, T.D.
United States National Park Service, South Florida Research Center, Everglades National Park, Homestead, Florida 33030.
Water Resources Bulletin, Vol. 14, No. 5, p 1227-1238, October, 1978. 4 fig, 1 tab, 20 ref, 7 equ.

Descriptors: Nutrients, Phosphorus, Water quality, Meanders, Channeling, Phosphates, Surface runoff, Dispersion, Mathematical models, Plankton.

Comparisons were made between rates of movement of orthophosphate in a canal and a meandering stream. The meander stream had greater algal and macrophyte phosphate uptake rates, and lower plankton and sediment release rates compared to the canal. Chemical precipitation and direct rainfall influences on orthophosphate movement were insignificant relative to other terms. The major source of phosphorus to both systems was from upland runoff. The impact of this source was greater on the meandering system due to the smaller channel volume. When secondary effects of meandering were considered such as march inundation, the net orthophosphate movement within the meandering channel was less than that for the canal; due to the lower concentrations of phosphorus in march effluent waters. Field experiments were conducted to compare the longitudinal dispersion coefficient between a canal and meandering river system; the meandering stream had a dispersion coefficient over 17 times that measured for the canal. Rates of orthophosphate movement were combined into a single mass transport equation, and a numerical solution was obtained. Internal river and canal channel processes were overshadowed by external point source loadings.

78:05G-031
A PARTITIONING PROCEDURE FOR WATER QUALITY MANAGEMENT MODELS,
Rossman, L.A., and Vanecek, F.T.
Environmental Protection Agency, Cincinnati, Ohio.
Water Resources Bulletin, Vol. 14, No. 4, p 842-855, August, 1978. 2 fig, 2 tab, 25 ref.

Descriptors: *Water quality, *Management, *Economic efficiency, *Partitioning procedure, *Optimization, Thermal pollution, Decision making, Standards, Water temperature, River systems, Dissolved oxygen, Biochemical oxygen demand, Mathematical models, Systems analysis, Equations, Cooling levels, Stream response, Nonlinear programming, Gradient search procedure.

An improved computational procedure for solving water quality management models containing interacting pollutants and control policies is presented. The method is developed with respect to the specific problem of minimizing the costs of basin-wide thermal and organic pollution control to meet water quality standards. It views the problem in partitioned form where a master problem is sued to find cooling levels for thermal polluters while subproblems determine optimal organic pollutant reductions for fixed cooling levels. A gradient-based search procedure is used to solve the master problem. Computational results for several river systems are presented. Application of the method to other water quality management models should improve computational efficiency and make the use of such models more attractive to basin planners.

78:05G-033
IMPROVING IRRIGATION RETURN FLOW QUALITY WITH A WATER RENTAL MARKET,
Huszar, P.C., and Sabey, M.B.
Colorado State University, Fort Collins, Department of Economics.
Water Resources Bulletin, Vol. 14, No. 4, p 978-987, August, 1978. 3 fig, 1 tab, 5 ref.

Descriptors: *Irrigation, *Return flow, *Water quality, *Improvement, *Rental market, Water transfer, Water allocation (policy), River systems, Effects, Costs, Water pollution, Conceptual model, Yakima Valley (Washington), Systems analysis.

Current policies for correcting the problem of irrigation return flow pollution tend to attack the symptoms of the problem rather than its cause. The present institutional arrangement for allocating irrigation water is seen as the source of the problem. This paper examines the water quality benefits of altering the institutional arrangement to allow for irrigation water transfers through a rental market. It is conceptualized that by creating a water rental market an opportunity cost would be associated with the use of irrigation water such that profit maximizing farmers would be induced to use water supplies more efficiently and rent the surplus to other irrigators, thus reducing return flow pollution. It is shown that a water rental market could improve water quality in the Yakima River in south central Washington by 31% as well as increase farm incomes and crop production.

78:05G-034
AN EVALUATION OF THE POTENTIAL FOR USING DRAINAGE CONTROL TO REDUCE NITRATE LOSS FROM AGRICULTURAL FIELDS TO SURFACE WATERS,
Gilliam, J.W., Skaggs, R.W., and Weed, S.B.
North Carolina State University, Raleigh, Department of Soil Science.
Water Resources Research Institute of the University of North Carolina, Raleigh, Report No. 128, January, 1978, 108 p. 23 fig, 4 tab, 32 ref, 2 append.

Descriptors: *Drainage control, *Nitrates, *Soil water movement, *North Carolina, Nitrogen, Agricultural soils, Surface waters, Denitrification, Agricultural runoff, Soil drainage, Coastal plain soils.

This study was an outgrowth of previous work which revealed that considerable denitrification occurred in poorly drained soils with high water tables. This resulted in less nitrate leaving fields in drainage waters than occurred in better drained soils. Two N.C. Coastal Plain sites were used: one in the poorly drained soils of the Tidewater area and the other in the moderately well drained soils of the Lower Coastal Plains. Flashboard rise type water control stuctures were installed in four main tile lines at each location. Each control structure was equipped with a weir and a stage recorder for computing total outflow of drainage water. A semi-proportional water sampler was installed at each weir to take samples for chemical analyses. The structures were very effective in controlling the loss of nitrate-nitrogen on the moderately well drained soils. The annual loss of nitrate-nitrogen under controlled conditions was 1-7 kg/ha as compared to the 25-40 kg/ha under uncontrolled conditions. This reduction is due entirely to prevention of water movement through the tile lines, however, and there is no indication that the water control resulted in the anticipated increased denitrification in the fields. Water table control on the poorly drained soils was much more successful. By controlling and maintaining the water table at higher levels, no significant difference in oxidation-reduction potential throughout the soil profile was observed. Also, there was no significant change in the nitrogen concentration in water leaving the fields in the drainage ditches under controlled and uncontrolled conditions.

78:05G-035

SALINITY MANAGEMENT OPTIONS FOR THE COLORADO RIVER, DAMAGE ESTIMATES AND CONTROL PROGRAM IMPACTS,

Andersen, J.C., Kleinman, A.P., Brown, F.B., Cannon, J.R., and d'Arge, R.C.
Utah Water Research Laboratory, Logan.
Water Resources Planning Series Report P-78-003, June, 1978, 344 p. 53 fig, 365 tab, 7 append.

Descriptors: *Economic efficiency, *Resource allocation, *Salinity, *Agricultural damages, *Alternative costs, *Colorado River, Regional analysis, Water quality, River basins, Water management (applied), Estimating, Costs, Economic impact, Input-output analysis.

Rivers draining arid basins increase in salinity content in the downstream area of the point where water users are often significantly damaged. The problem in some cases can be ameliorated by altering upstream water and land use practices. An economic trade-off exists between the cost of such upstream efforts and the downstream benefits achieved. This study sought to provide additional information to estimate (1) economic and (2) economic costs of salinity control measures by upstream water users. Damages were estimated for high salinity levels to provide guidelines to project future conditions. Control costs were estimated with a physical model developed to predict the response of soil, water, and crop factors. Input-output models were used to estimate indirect economic impacts.

78:05G-036

EFFICIENT AMENDMENT USE IN SODIA SOIL RECLAMATION,

Prather, R.J., Goertzen, J.O., Rhoades, J.D., and Frenkel, H.
Institute of Soils and Water, Volcani Center, P.O. Box 6, Bet Dagan, Israel.
Soil Science Society of America Journal, Vol. 42, No. 5, p 782-786, September-October, 1978. 8 fig, 5 tab, 9 ref.

Descriptors: Reclamation, Alkali soils, Soil amendments, Calcium sulfate, Gypsum, Calcium chloride, Sodium, Leaching, Regression analysis.

A laboratory column study of sodic soil reclamation was carried out using two soils high in exchangeable sodium percentage (ESP) and cation exchange (CEC). Three amendments ($CaSO_4 \cdot 2H_2O$, $CaCl_2 \cdot 2H_2O$, and H_2SO_4) were used singly and in combination to test their effectiveness and efficiencies with respect to amount of amendment, time, and leaching needed. As a single amendment, H_2SO_4 was found to be more effective than $CaSO_4$ and results in a more desirable ESP profile than $CaCl_2$. Combining either $CaCl_2$ or H_2SO_4 with $CaSO_4$ (proportions of 1/4 and 3/4, respectively) appreciably reduced the time and leaching needed to achieve reclamation as compared with $CaSO_4$ alone. It was observed that certain soil conditions preclude or make undesirable the use of $CaSO_4$ alone and combining amendments results in effective reclamation and a potential savings in amendment costs.

78:05G-037

VARIABILITY OF ANNUAL NUTRIENT AND SEDIMENT DISCHARGES IN RUNOFF FROM OKLAHOMA CROPLAND AND RANGELAND,

Menzel, R.G., Rhoades, E.D., Olness, A.E., and Smith, S.J.
Agricultural Research Service, Durant, Oklahoma, Water Quality Management Laboratory.
Journal of Environmental Quality, Vol. 7, No. 3, p 401-406, 1978. 4 fig, 4 tab, 22 ref.

Descriptors: *Oklahoma, *Fertilizers, *Nutrients, *Agricultural runoff, *Sediment yield, *Water quality, *Soluble nutrients, Nitrates, Agricultural chemicals, Water pollution sources, Nitrogen compounds, Nitrogen, Phosphorus, Soil properties, Water pollution, Rainfall, Soil erosion, Sediments, Pollutants.

Nitrogen and phosphorus discharges in runoff from nearly level cropland and 3% sloping rangeland were measured from July 1972 to June 1976. Sediment discharges and runoff amounts from these 5- to 18-ha watersheds were measured from July 1966 to June 1976. Sediment and nutrient discharges varied greatly from year to year and between different land uses. It was concluded that long records are needed to compare discharge from different management practices. The average and maximum annual sediment discharges, respectively, were 3,600 and 8,900 kg/ha from irrigated cotton, 900 and 3,900 kg/ha from dryland wheat, 400 and 1,800 kg/ha from range with limited grazing, and 9,000 and 23,000 kg/ha from overgraze range. Maximum annual sediment discharges occurred during the period in which nutrient discharges were measured. Maximum annual nutrient discharges were 13 kg/ha total N, 4 kg/ha nitrate N, 11 kg/ha total P, and 2 kg/ha soluble P. The average annual discharge for each nutrient form and land use was about half of its maximum value. Nitrate accounted for 10 to 30% of the total N discharged. Soluble phosphate accounted for about 20% of the total P discharged from cropland and less than 10% of that discharged from rangeland. Annual deposition in rainfall averaged kg/ha N and 0.15 kg/ha P.

78:05G-038

IRRIGATION WATER SALT CONCENTRATION INFLUENCES ON SEDIMENT REMOVAL BY PONDS,

Robbins, C.W., and Brockway, C.E.
Agricultural Research Service, Kimberly, Idaho, Snake River Conservation Research Center.
Soil Science Society of America Journal, Vol. 42, No. 3, p 478-481, May-June, 1978.
2 fig, 2 tab, 12 ref.

Descriptors: *Sediment control, *Irrigation, *Salts, *Irrigation return flow, Ponds, Water treatment, Coagulation, Flocculation, Runoff, Sediments, On-site investigation, Laboratory tests, Irrigation water, Irrigation practices, Sedimentation.

Irrigation water salt concentration effects on sediment pond efficiency were investigated to demonstrate the necessity of considering the salt concentration in the irrigation waters when designing sediment retention ponds. The influence of dissolved salt was determined by adding concentrated $CaCl_2$ solutions to three ponds and then measuring electrical conductivities and sediment concentrations at the pond outlets. Increasing the salt concentration increased the sediment removal efficiencies when the retention time in the pond exceeded 1 hour or the inflow sediment concentration exceeded 500 ppm for the three soils studied. Adding salt to laboratory soil sample suspensions increased the settling rates for the two soils studied. That data indicated that the salt concentration in irrigation water is an important factor in determining sediment pond size and retention time. Using pond design criteria obtained from sediment ponds receiving water of a given salt concentration to design ponds that will receive water with a different salt concentration should include adjustments for salt concentration differences. A simple laboratory test was suggested to predict which soils will respond to irrigation water salt concentration changes that are likely to result in sediment pond efficiency changes.

78:05G-039

DEVELOPMENT OF MANAGEMENT GUIDELINES TO PREVENT POLLUTION BY IRRIGATION RETURN FLOW FROM RICE FIELDS,

Brown, K.W., Deuel, L., Price, J., DeMichele, D., and Teague, W.R.
Texas A & M University, College Station, Texas.
Publication No. EPA-600/2-78-082, April, 1978. 570 p, 147 fig, 78 tab, 170 ref, 15 append, 96 equ.

Descriptors: Water management (applied), Water quality control, Water quality, Return flow, Water pollution control, Rice, Irrigation practices, Fertilization, Ion transport, Computer programs.

A three-year field and laboratory study was conducted to determine the influence of management practices on the quantity and quality of irrigation return flow from rice paddies. Continuous and intermittent irrigation techniques were used on replanted field plots which received either recommended or excessive applications of fertilizer and four selected pesticides. Water quality was evaluated with respect to fertilizer amendments, pesticides, pH and total salt load. Pesticides monitored included propanil molinate, carbofuran, carbaryl and their respective metabolites. Present water management practices result in large return flow volumes. Occasionally concentrations of NH4 exceeded drinking water standards. Losses of nitrate were below such limits and the total nitrogen losses were a small fraction of the fertilizer applied. A model was developed to simulate the ionic constitency of the return flow. Propanil was washed from the foliage into the flood water and dissipated within 24 hours. Evidence is given that carbaryl is washed from the leaves by rainfall, thus providing available source to contaminate return flow. As long as 8 days were required to dissipate residue resulting from recommended applications. Retention times to assure low concentrations in the irrigation return flow for carbofuran are of the order of 16 days. Granular applied molinate necessitates a retention time of 4 days to assure concentrations are within 10% of the TLM to fish. It is suggested that through improved water management and knowledge of dissipation rates, the quanity of irrigation return flow can be reduced and the quality improved.

78:05G-040
TIMING AND RATE OF FERTILIZER NITROGEN FOR SUGARBEETS RELATED TO NITROGEN UPTAKE AND POLLUTION POTENTIAL,
Hills, F.J., Broadbent, F.E., and Fried, M.
California University, Davis, Department of Soil Microbiology.
Journal of Environmental Quality, Vol. 7, No. 3, p 368-372, July-September, 1978.
4 fig, 3 tab, 11 ref.
(See 78:02I-030)

78:05G-041
THE PESTICIDE CONTENT OF SURFACE WATER DRAINING FROM AGRICULTURAL FIELDS--A REVIEW,
Wauchope, R.D.
Southern Weed Science Laboratory, Science and Education Administration, Federal Research, United States Department of Agriculture, Stoneville, Mississippi 38776.
Journal of Environmental Quality, Vol. 7, No. 4, p 459-472, October-December, 1978.
3 fig, 4 tab, 69 ref.
(See 78:10C-003)

78:05G-042
LEACHING OF CATIONS AND CHLORIDE FROM MANURE APPLIED TO AN IRRIGATED SOIL,
Pratt, P.F.
California University, Riverside, Department of Soil Science.
Journal of Environmental Quality, Vol. 7, No. 4, p 513-516, October-December, 1978.
3 fig, 15 ref, 8 equ.

Descriptors: Leachate, Leaching, Organic wastes, Cations, Chlorides, Irrigation, Water pollution, Water quality, Water management (applied).

Data for leached cations, (the sum of Ca(2+), Mg(2+), Na(+) and K(+)), and leached Cl(-) and the ratio of cations to Cl(-) leached from the root zone during a 4-year experiment with bovine manures on a Hanford soil were presented. Cation accumulation in the soil and the cations leached were linearly correlated with cation input. The removal of cations in harvested crops reached a maximum and then decreased as the input of cations increased. Leached Cl(-) increased at a ratio of 1:1 with the Cl(-) input in excess of removal in harvested crops, whereas leached cations increased with increase in inputs in excess of removal in crops and decreased with decrease in the volume of leachate. At low leachate volumes and with dry weights of liquid and solid manures at 21 and 40 metric tons/ha per year, respectively, the cations leached were less than in the check plots. At high leachate volumes manures increased the cations leached relative to the check treatment at all rates of manure. The dominant factor in cation leaching was volume of leachate. Carefully controlled irrigation to attain low leachate volumes combined with manure applications at reasonable rates could be used to reduce the overall effect of irrigation on the leaching of salts to groundwater.

78:05G-043
NITROGEN AND PHOSPHORUS LOSSES IN RUNOFF FROM NO-TILL SOYBEANS,
McDowell, L.L., Ryan, M.E., McGregor, K.C., and Greer, J.D.
Sedimentation Laboratory, Oxford, Mississippi, United States Department of Agriculture.
Paper No. 78-2508, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 8 p. 10 fig, 4 tab, 18 ref.

Descriptors: Water pollution, Water pollution control, Nitrogen, Phosphorus, Soil erosion, Runoff, Nutrients, Water quality control, Soybeans, Mississippi.

No-till soybeans and corn can be grown on highly erodible loessial soils in north Mississippi with reduced soil and plant nutrient losses. Soil loss in 1973 from no-till soybeans, planted directly through previous crop residues, was only 0.4 metric tons per hectare (t/ha) compared with 19 t/ha from conventional till. Total (solution plus sediment) nitrogen (N) and phosphorus (P) losses from no-till soybeans were only 4.7 and 2.8 kg/ha, respectively, compared with 46.4 and 17.6 kg/ha from conventional till. Where applicable, no-till is a best management practice for reducing potential nonpoint pollution by sediments and plant nutrients in surface runoff from agriculture.

78:05G-044
MINIMIZING SALT IN DRAIN WATER BY IRRIGATION MANAGEMENT--DESIGN AND INITIAL RESULTS OF ARIZONA FIELD STUDIES,
Hoffman, G.J., Dirksen, C., Ingvalson, R.D., Maas, E.V., and Oster, J.D.
United States Salinity Laboratory, Agricultural Research Service, United States Department of Agriculture, 4500 Glenwood Drive, Riverside, California 92502.
Agricultural Water Management, Vol. 1, No. 3, p 233-252, November, 1978. 11 fig, 3 tab, 19 ref.

Descriptors: Water management (applied), Salinity, Drainage water, Water quality, Leaching, Return flow, Evapotranspiration, Oranges, Alfalfa, Arizona.

Two field experiments were established in the Wellton-Mohawk Irrigation and Drainage District of southwestern Arizona to test the feasibility of decreasing the salt load in drainage water by reduced leaching. Results were given for the initial 2 years of the test for Valencia orange trees and the first year for alfalfa. The water application data, substantiated by salinity sensor readings and measures of soil chloride, indicated that the annual evapotranspiration of Valencia orange was approximately 1375 mm on a total area basis. After 2 years, fruit yield and quality and tree growth were not significantly different from flood-irrigated trees that received 40% more water. It was concluded that if these results persist, the salt load from citrus in the district could be reduced 40,000 Mg annually by reduced leaching. More importantly, because of the salinity of the groundwater pumped for water table control, the salt load exported from the district could be reduced initially by 130,000 Mg annually. Results indicated that the alfalfa experiment was underirrigated the first year and evapotranspiration was about 1950 mm annually. Comparisons indicated that the level basin flood irrigated check yielded 20% more than the experiment and had about 10% leaching, an efficiency that can probably not be improved.

78:05G-045
RESIDUAL NITRATE-N IN FINE SAND AS INFLUENCED BY N FERTILIZER AND WATER MANAGEMENT PRACTICES,
Smika, D.E., and Watts, D.G.
United States Department of Agriculture, Science and Education Administration, Akron, Colorado.
Soil Science Society of America Journal, Vol. 42, No. 6, p 923-926, November-December, 1978. 5 fig, 1 tab, 6 ref.

Descriptors: Nitrogen, Nitrates, Water management (applied), Nitrification, Application methods, Irrigation systems, Groundwater, Water pollution, Return flow, Corn (field).

This study showed that on fine sandy soils fertilizer N and water management are the key to controlling NO3(-)N movement below the root zone of an irrigated corn crop. When the N was applied in one broadcast application at seeding, very little NO3(-)N remained in the soil at the end of the growing season, regardless of the amount of growing season water application. Overwinter leaching of NO3(-)N below the 150-cm sampling depth was minimal with 13 cm of precipitation received during these months. When N was applied through the solid set sprinkler irrigation system during the growing season before tasseling, water application rate and total N applied determined the amount of NO3(-)N that remained in the soil at the end of the growing season. During the overwinter period, NO3(-)N actually increased in the soil due to nitrification of some of the NH4(+)-N. With proper N application and water management, the potential for NO3(-)N leaching below the crops' root zone can be greatly reduced.

78:05G-046

RELATIONSHIPS BETWEEN AGRICULTURAL LAND AND WATER QUALITY,

Coote, D.R., MacDonald, E.M., and DeHaan, R.

Land Resource Research Institute, Central Experimental Farm, Agriculture Canada, Ottawa, Ontario.

Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 79-92. 5 tab, 11 ref.

Descriptors: Water quality, Water pollution, Land use, Agricultural watersheds, Agricultural chemicals, Statistical methods, Great Lakes, Regression analysis.

The study described in this paper was developed as an adjunct to the Pilot Watershed Studies of the International Reference Group on Great Lakes Pollution from Land Use Activities (PLUARG) of the International Joint Commission (IJC) with the objective of determining the relationships among water quality, pollutant loadings and land use data gathered in watersheds representative of different agricultural areas. The approach taken was to: (1) identify and survey a number of purely agricultural watersheds (nonagricultural land use essentially absent) representative of different agricultural systems in the Canadian Great Lake Basin; (2) monitor the water quality at the watershed outlet; and (3) examine statistical relationships between the characteristics of these watersheds and the water quality observed at their outlets. A further objective of the study was to provide a basis for predictions of water quality in unmonitored agricultural areas of the Canadian Great Lakes Basin.

78:05G-047

BEST MANAGEMENT PRACTICES FOR AGRICULTURE AND SILVICULTURE: AN INTEGRATED OVERVIEW,

Bailey, G.W., and Waddell, T.E.

United States Environmental Protection Agency, Environmental Research Laboratory, Athens, Georgia.

Proceedings of the 1978 Cornell Agricultural Water Management Conference, p 33-56. 5 fig, 3 tab, 17 ref.

Descriptors: Water management (applied), Management, Water pollution control, Water pollution sources, Water quality, Legislation, Social aspects, Economic feasibility, Institutional constraints, Forest management.

The evolution of agricultural and silvicultural practices were examined to place the environmental effectiveness of BMPs in perspective within today's control efforts. In addition, recent legislation was reviewed in terms of BMP identification, selection, and implementation approaches. The technical, social, and economic aspects of BMPs were examined by means of a systems approach. First, the physical system characterized by natural and man-made inputs, system properties (e.g., topography and soil) and outputs/pollutant load (i.e., sediment, pesticides, plant nutrients, heavy metals, pathogens and easily oxidizable organics) were discussed. Second, this system was viewed as a partially controllable system within the context of a larger socio-economic setting driven by a multiplicity of exogenous forces. Socio-economic aspects of BMPs were discussed in terms of economic efficiency, social acceptability, equity, implementation incentives, and institutional arrangements. The paper identified and discussed a number of critical issues that demand attention.

78:05G-048
CONSERVATION DISTRICT INVOLVEMENT IN 208 NONPOINT SOURCE IMPLEMENTATION,
Williams, R.E., and Lake, J.E.
National Association of Conservation Districts, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 57-67.

Descriptors: Water pollution control, Water quality act, Water law, Legislation, Water management (applied), Erosion control, Sediment control, Water pollution sources, Water quality, Soil conservation.

A brief history of the establishment of conservation districts was presented including their authorities under the state laws enabling conservation districts organization. In addition, fifteen states have passed additional legislation providing districts with the authority to participate in special erosion and sediment control programs. Examples of how these programs are working in several of the states were discussed. The relationships of these and other programs with the new thrust toward implementing nonpoint water quality plans using the Best Management Practice approach was covered. Three case studies were presented where districts have demonstrated their abilities to be management agencies for implementing Best Management Practices. Finally, conservation districts' involvement in carrying out 208 nonpoint implementation as a result of recent legislation (ex: Culver amendment) was provided. Administrative, technical, and funding roles of state soil conservation agencies and conservation districts in implementing BMP's were stressed.

78:05G-049
THE ROLE OF CONSERVATION PRACTICES AS BEST MANAGEMENT PRACTICES,
Johnson, J.S.
Soil Conservation Service, United States Department of Agriculture, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 69-78. 16 ref.

Descriptors: Water pollution control, Water pollution, Water quality control, Water quality act, Water quality, Soil conservation, Management, Water pollution sources, Irrigation, Water conservation.

The combination of conservation practices selected to meet the needs of a particular land and water problem and achieve the desired results was viewed as a resource management system. Experience and research have shown that many resource management systems are highly effective in protecting and improving water quality. The resource management system selected may include agronomic, managerial, and structural practices that reduce nonpoint source pollution and protect water quality. The best resource management system is one that keeps the water where it falls, protects the resource base, and maintains water quality of the water that runs off. It was suggested that such proved resource management systems can be used in achieving national goals of improved water quality, and because of the recognized effectiveness of conservation practices and resource management system in controlling nonpoint source pollution, many of them can be selected and listed as BMP in Section 208 Water quality Management plans.

78:05G-050
INTEGRATING WATER QUALITY AND BEST MANAGEMENT PRACTICES,
Taverni, A.F., and Dworsky, R.F.
The New York State Assembly, Research Staff, Albany, New York.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 93-115. 4 fig, 6 tab, 15 ref.

Descriptors: Water quality control, Water quality, Water pollution control, Water quality act, Planning, Management, Water pollution, Hudson River, Salinity.

This paper discusses in detail the New York State Level B plans (section 209 of Public Law 92-500) which contribute to improved water quality through the use of common techniques. Specifically, this paper focused on the Genesee River, Hudson River and Lake Champlain. It provided a summary of Best Management Practices and the relation of Best Management Practices to overall water quality management. Lastly, this paper demonstrated the viability of a state integrated planning approach.

78:05G-051
ENVIRONMENTAL IMPLICATIONS OF TRENDS IN AGRICULTURE AND SILVICULTURE,
Unger, S.G.
Development Planning and Research Associates, Incorporated, Manhattan, Kansas.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference,
p 117-131. 1 fig, 2 tab.

Descriptors: Environmental sanitation, Pollutant identification, Water pollution sources, Water quality control, Agriculture, Pasture management, Range management, Forest management, Environmental control, Pollution abatement.

In a study sponsored by the Environmental Protection Agency (EPA) the environmental implications of production-related trends were assessed in the following five subsectors: Agriculture--(1) Nonirrigated crop production, (2) Irrigated crop production, (3) Livestock feedlot production, (4) Range and pasture management, and, Silviculture--(5) Silviculture and harvest management. The period of analysis was 1976-2010, and the emphasis was on the long-term future under moderate growth assumptions. This presentation summarized the findings of the EPA study including the rating and rankings--by a national evaluation workshop--of environmentally-related trends within each of the five subsectors. Also, a further analysis of the various types of trends within the crop production subsectors was made to determine the relative importance of management practices--compared to input-use restraints and residual-output treatments--within the crop production system as a potential means of environmental pollution control in the future.

78:05G-052
ESTIMATION AND MANAGEMENT OF THE CONTRIBUTION BY MANURE FROM LIVESTOCK IN THE ONTARIO GREAT LAKES BASIN TO THE PHOSPHORUS LOADING OF THE GREAT LAKES,
Draper, D.W., Robinson, J.B., and Coote, D.R.
Guelph University, Guelph, Ontario, Canada, Department of Environmental Biology.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 159-174. 2 fig, 4 tab, 39 ref, 3 equ.
(See 78:05A-016)

78:05G-053
THE FATE OF NITRATE IN SMALL STREAMS AND ITS MANAGEMENT IMPLICATIONS,
Robinson, J.B., Whiteley, H.R., Stammers, W., Kaushik, N.K., and Sain, P.
Guelph University, Geulph, Ontario, Canada, Department of Environmental Biology.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 247-259.
6 fig, 2 tab, 20 ref.
(See 78:05B-064)

78:05G-054
AN APPROACH TO WATER RESOURCES EVALUATION OF NONPOINT SOURCES FROM SILVICULTURAL ACTIVITIES--A PROCEDURAL HANDBOOK,
Currier, J.B., Siverts, L.E., and Maloney, R.C.
Watershed Systems Development Group, United States Department of Agriculture--Forest Service, Fort Collins, Colorado.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 271-280.
1 fig, 1 ref.
(See 78:05B-065)

78:05G-055
NONPOINT SOURCE POLLUTION FROM AGRICULTURE: SOME SOCIOLOGICAL CONSIDERATIONS FOR IMPLEMENTING POLICY,
van Es, J.C., and Keasler, L.C.
Illinois University, Urbana-Champaign, Department of Agricultural Economics.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 311-319.
1 fig, 8 ref.

Descriptors: Water pollution control, Social aspects, Social participation, Water pollution, Water quality, Water quality control, Water policy, Water management (applied).

Most of the discussion on NPS pollution control deals with the economics and the technical aspects of the issue. In this paper the contributions sociological analysis can make to the administration and implementation of a NPS-pollution control program were demonstrated. The first theme developed in the paper dealt with the distinction between policy goals and the objectives of specific programs created to reach the policy goals. The second theme dealt with the issue of participation in programs. The paper discussed the experience in agriculture with voluntary and mandatory programs of change and the likely consequences of choosing programs with voluntary or mandatory participation strategies. It was concluded that the program administrators will be in a better position to administer programs if they understand the relationship of the program objectives to the policy goal and make program implementation compatible with the various programs objectives.

78:05G-056
ANIMAL MANURE MOVEMENT IN WINTER RUNOFF FOR DIFFERENT SURFACE CONDITIONS,
Thompson, D.B., Loudon, T.L., and Gerrish, J.B.
Minnesota University, St. Paul, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 145-157. 1 fig, 4 tab, 16 ref.
(See 78:05A-018)

78:05G-057
ESTIMATING PHOSPHORUS LOADING FROM LIVESTOCK WASTES: SOME WISCONSIN RESULTS,
Moore, I.C., Madison, F.W., and Schneider, R.R.
Wisconsin University, Madison, Water Resources Center.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 175-192. 3 fig, 7 tab, 17 ref.
(See 78:05A-019)

78:05G-058
ECONOMIC IMPACTS OF POLICIES TO CONTROL EROSION AND SEDIMENTATION IN ILLINOIS AND OTHER CORN-BELT STATES,
Seitz, W.D., Osteen, C., and Nelson, M.C.
Illinois University, Urbana, Institute for Environmental Studies.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 373-382. 10 ref.

Descriptors: Erosion control, Sediment control, Sedimentation, Soil erosion, Economic impact, Agricultural watersheds, Linear programming, Water pollution control, Water quality control, Corn belt.

This paper addressed 1) the costs to society of controlling agricultural nonpoint sources of pollution, specifically erosion and sedimentation, and 2) the variation in economic impacts as states or/and areas enact varying levels of control. A large linear programming model of the corn-belt region which accounts for variable corn and soybean production and prices was used in the analysis. This model was used to evaluate alternative erosion control policies implemented in selected areas of the corn belt. At the corn belt level, impacts on social cost, farm income, food costs, commodity prices and production, land use, and soil loss were discussed. The analysis of varying controls by areas was measured in terms of impacts on the comparative advantage, farm income, crop production, land use and soil loss of controls applied in Illinois and Wisconsin. The paper also reported the results of an analysis of the long-run impacts of soil erosion and soil erosion control policies on farm income. This analysis was conducted on a representative watershed using a series of linear programming models with adjustments to reflect the impacts of erosion on productivity.

78:05G-059
INSTITUTIONAL AND TECHNICAL ASPECTS OF THE DEVELOPMENT OF AGRICULTURAL BMPs IN A GIVE-COUNTY RURAL/URBAN MICHIGAN REGION,
Jones, J.P., and Sutherland, J.C.
Williams & Works, Incorporated, Grand Rapids, Michigan.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 455-462. 2 fig.

Descriptors: Runoff, Soil erosion, Waste treatment, Water quality, Water pollution, Management, Water pollution control, Water law, Michigan.

This is a case history of the development of a truly management oriented Waste Treatment Management Plan under the provisions of Section 208 of Public Law 92-500. It emphasized the management organization at all levels--state, regional and local--for the implementation of best management practices to control nonpoint diffuse sources of water pollution. Major emphasis of the control and management effort was directed toward urban and rural runoff and sedimentation; agricultural pollution such as that from herbicides and pesticides; pollution from construction practices and lesser nonpoint sources of water pollution such as septic systems and sanitary landfills.

78:05G-060
DEVELOPMENT OF BMPs FOR AGRICULTURE--NEW YORK STATE STRATEGY,
Robillard, P.D., Walter, M.F., and Gilmour, R.
Cornell University, Ithaca, New York, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 581-595. 7 fig, 7 tab, 6 ref.

Descriptors: Water quality control, Water pollution control, Water quality, Water pollution, Water management (applied), Soil conservation, Farm management, Planning, New York, Sediment control.

The identification of specific problems, knowledge of the cause-effect relationships, direct installation costs and expected changes in farm income circumvent the choice of appropriate BMP's and their potential water quality benefits. How these concepts might be incorporated into a BMP development program for New York State were reviewed. Associated stages of BMP development and implementation techniques were proposed. Examples of this methodology were presented for two case study dairy farms. Candidate management practices were judged qualitatively and quantitatively in reducing potential soil, plant nutrient and manurial organic matter losses from cropland. Estimated changes in farm income were calculated for each measure. The risk in adopting new farm management measures and technology were considered in this BMP selection process. The potential for integrating soil erosion, agronomic recommendations and farm management concepts into the water quality elements of conservation farm plans were found to be good. Examples of this approach were presented.

78:05G-061
DEVELOPMENT OF A "208 PLAN" FOR AGRICULTURAL NONPOINT POLLUTION SOURCES IN ILLINOIS,
Vanderholm, D.H., Frank, J.F., and Taylor, A.G.
Illinois University, Urbana-Champaign, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 563-580.

Descriptors: Water pollution control, Water quality control, Water pollution, Water quality, Planning, Pollution abatement, Water pollution sources, Soil conservation, Illinois.

In June 1976, a task force on Agricultural Non-Point Sources of Pollution was appointed to advise the Illinois Environmental Protection Agency in producing a comprehensive water pollution control plan. Task force membership included representatives from agriculture, state and federal agencies, universities, and environmental groups. The task force was divided into subcommittees to deal with the specific areas of pesticide, soil erosion, fertilizers, livestock waste and forestry and fruit production. The problem assessment phase of the plan was completed in March of 1977 and the recommended Best Management Practices (BMPs) were completed in October, 1977. The last phase of the report deals with recommended implementation methods and was completed in March 1978. The objective of this paper was to report the approach used by the task force for assessment of the pollution problem from agricultural nonpoint sources, suggested BMPs, and implementation strategy as recommended by the task force for adoption in Illinois.

78:05G-062
APPROACH FOR ANALYZING AND MANAGING AGRICULTURAL NONPOINT SOURCES IN THE STATE OF MARYLAND,
Schoenhofer, R.F., Knight, W.A., and Hancock, C.V.

Water Resources Administration, State of Maryland Department of Natural Resources, Annapolis, Maryland.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 551-561. 2 fig, 9 ref.

Descriptors: Water pollution control, Water quality control, Water quality, Water quality act, Water pollution sources, Maryland, Management, Decision making, Planning, Agricultural chemicals.

This paper covered the following topics: (1) A description of the State of Maryland, its 208 planning areas and agencies, and a brief history of nonpoint source control efforts before the onset of 208 planning, which was prompted by P.L. 92-500; (2) A description of the organizational structure of the agencies involved in 208 planning as it related to agriculture; (3) A description of the philosophy and the benchmark decisions relating to the development of the agricultural nonpoint source management program; and (4) A description of an information management system developed by the 208 program in cooperation with the Soil Conservation Districts, and its application as a part of program development.

78:05G-063
ESTIMATION OF AGRICULTURAL NONPOINT LOADS TO THE WAKARUSA RIVER BASIN USING THE "NONPOINT CALCULATOR",
Davis, M.J., and Nebgen, J.W.
Midwest Research Institute, Kansas City, Missouri.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 525-550. 1 fig, 14 tab, 2 ref, 7 equ.

Descriptors: Water pollution, Water quality, Water pollution control, Land management, Programs, Agricultural watersheds, Sediment load, Pollutants, Estimating, Kansas.

An analysis of the nonpoint pollution sources in the Wakarusa River basin in eastern Kansas was undertaken. The Wakarusa basin is primarily rural, with the principal nonpoint pollutant loads arising from agricultural land. Soil Conservation Service information for this basis was used to develop the "nonpoint calculator," a computerized methodology for estimating nonpoint loads. This procedure was developed under the sponsorship of the U.S. Environmental Protection Agency. The nonpoint calculator considers a variety of sources; pervious areas (erosion-related pollutants), impervious areas (urban sources), feedlots, landfills, salinity from irrigation return flow, and acid mine drainage. For the Wakarusa River basin study, the nonpoint calculator was used only for previous agricultural land. The presentation described how the nonpoint calculator operates, and the type of information needed for input. It was shown that analysis of the output from the nonpoint calculator can pinpoint areas which require the development of plans for load reduction, either to preserve water quality or to maintain the soil resource.

78:05G-064
INTERACTIVE EFFECTS OF PESTICIDE PROPERTIES AND SELECTED CONSERVATION PRACTICES ON RUNOFF LOSSES: A SIMULATION STUDY,
Dean, J.D., and Mulkey, L.A.
Technology Development and Applications Branch, Environmental Research Laboratory, United States Environmental Protection Agency, Athens, Georgia.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 715-734. 7 fig, 3 tab, 28 ref.

Descriptors: Agricultural runoff, Pesticide removal, Conservation, Simulation analysis, Agricultural chemicals, Management, Sediment discharge, Water pollution, Water pollution control, Water quality.

The prohibitive cost of long-term collection of chemical runoff data from agricultural activities makes the use of models attractive in evaluating impacts of management practices. This paper described a general methodology for model implementation and cited a specific case to indicate the potential of simulation studies for characterizing runoff losses. To test the methodology, a study was made using two different conservation practices on opposite ends of the managerial spectrum, three different sorptive pesticide properties, ten gradually increasing pesticide half-lives, and three meteorological input sequences for a total of 180 simulation years. The U.S. Environmental Protection Agency's Agricultural Runoff Management Model (ARM) and data from the Southern Piedmont agricultural region were used in the investigation. Results showed the interactive effects of pesticidal properties, watershed hydrology, and conservation practices on runoff losses of the chemicals, in water and on sediment.

78:05G-065
MODELING SOIL AND WATER CONSERVATION PRACTICES,
Beyerlein, D.C., and Donigian, A.S.
Hydrocomp, Incorporated, Palo Alto, California.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 687-713. 9 fig, 4 tab, 16 ref, 5 equ.

Descriptors: Agricultural runoff, Water conservation, Soil conservation, Water pollution, Model studies, Water quality, Agricultural watersheds, Sediment discharge, Frequency analysis, Watershed management.

The U.S. Environmental Protection Agency's agricultural Runoff Management (ARM) Model was used to study the effects of soil and water conservation practices (SWCP) on nonpoint pollution from agricultural lands. The base conditions were defined as conventional agricultural practices for the region. Model parameters were then changed to represent the effects of a particular SWCP. The three major SWCPs studied were terracing, contouring, and conservation tillage. Continuous simulations of three to ten years in length were made to quantify the effects of each of the SWCPs compared to the base conditions. Runoff, sediment loss, and pesticide and nutrient washoff in solution and on sediment for a SWCP were compared with the base condition results. Results were analyzed both by total monthly and yearly amounts and by frequency of occurrence. ARM Model results were displayed with a Calcomp plotter to give a visual representation of how and when runoff and pollutant amounts changed with different SWCPs. The simulation methodology, the selection and evaluation of model parameters for particular practices, and the evaluation of the results in terms of the effects of different SWCPs were discussed. Limitations of the model to represent certain agricultural practices were presented along with areas for future research.

78:05G-066
MATHEMATICAL MODELING OF WATER QUALITY EFFECTS OF AGRICULTURAL BEST MANAGEMENT PRACTICES,
Tang, C.
URS Company, Seattle, Washington.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 625-647. 6 fig, 5 tab, 5 ref.

Descriptors: Water quality control, Water pollution control, Water quality, Water pollution, Mathematical models, Agricultural runoff, Biochemical oxygen demand, Ammonia, Coliforms, Washington.

A series of computer models were used in the SNOMET/King County (Washington State) 208 study to determine the water quality effects of the implementation of best management practices (BMPs) designed to reduce nonpoint pollutant runoff from agricultural activities. Simulated results showed that under existing land use conditions, the pollutant reductions for BOD, ammonia and fecal coliform loads in the study area after BMP application were about 70%, 85% and 75%, respectively. Under the simulation condition, a combination of 7 day - 10 year low flow regime and an annual summer storm, the results showed that the in-stream concentration of fecal coliforms after BMP application in the Upper Snohomish River, was greatly improved from a frequent violation to a satisfactory level with respect to the State Standards. The results of these simulations helped to guide in the selection of BMPs for the agricultural areas.

78:05G-067
THE EVALUATION OF BEST MANAGEMENT PRACTICES FOR THE REDUCTION OF DIFFUSE POLLUTANTS IN AN AGRICULTURAL WATERSHED,
Cahill, T.H., Pierson, R.W., and Cohen, B.
Resource Management Associates, West Chester, Pennsylvania.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 465-490. 14 fig, 9 tab, 10 ref.

Descriptors: Agricultural watersheds, Land management, Water pollution, Water quality, Water quality control, Agricultural runoff, Eutrophication, Lake Erie, Model studies, Great Lakes.

The Honey Creek watershed (180 s.m.) in the Sandusky basin of north central Ohio has been the subject of research by several agencies and institutions during 1976 and 1977. The basin has served as a pilot study area for the development of agricultural land management practices to reduce phosphorus input to Lake Erie. A computerized land resource data base has been created to evaluate options. Current research centers on the calibration of the EPA Nonpoint Source Model (NPS) for the watershed, with model parameter evaluation for BMP sensitivity. Because of the size of the basin with respect to prior NPS model calibration studies, 14 subbasin simulations were produced using the data base. Routing sub-routines were developed, using wave velocity for hydrographs and particle velocity for chemographs. Recommendations were made for model parameter inputs, to reflect greater sensitivity for management analysis.

78:05G-068
A STATE PERSPECTIVE ON NONPOINT SOURCE MANAGEMENT,
Berle, P.A.A.
New York State Department of Environmental Conservation, Albany, New York.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 17-24.

Descriptors: Water pollution control, Water quality control, Water quality act, Soil conservation, Water conservation, Water management (applied), State governments, New York.

This paper projects the governmental perspective of the New York state on nonpoint pollution control strategy. The concept of Best Management Practice (BMP) for nonpoint source control and management was endorsed. To prevent water pollution from rural nonpoint sources, it was felt necessary to develop BMP's tailored to meet New York's unique physical, economic and agricultural conditions; to identify serious nonpoint water quality problems for special priority attention; and participation by every landowner in the existing cooperative soil and water conservation program. It was concluded that since technically nonpoint pollution control is a new and relatively unexplored area of concern, the initial BMP systems must be carefully designed to stay within the limits of our current knowledge.

78:05G-069
BEST MANAGEMENT PRACTICES FOR SILVICULTURE,
Harper, W.C.
Weyerhaeuser Company, Tacoma, Washington.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 263-270.

Descriptors: Forest management, Forest watersheds, Water quality control, Water pollution control, Water quality, Management, Water quality act, Pollution abatement.

The silvicultural aspects related to Section 208 planning of Public Law 92-500 was addressed to ensure that the resulting plan is compatible with long-term forest management objectives. It was suggested that alternative management practices are developed for each site to allow land managers to select among an appropriate range of acceptable management practices. It was also suggested that an assessment of the effectiveness of Best Management Practices in meeting land management goals, including both water quality and timber production, must be conducted following implementation of the 208 plan.

78:05G-070
BEST MANAGEMENT PRACTICES FOR FERTILIZER USE,
White, W.C., and Plate, H.
The Fertilizer Institute, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 133-141.
3 tab, 9 ref.

Descriptors: Nutrient removal, Nutrient requirements, Fertilizers, Environmental sanitation, Water pollution, Water quality, Management, Application methods, Timing, Water quality control.

A few examples were presented to illustrate the wide range of factors to consider in controlling nutrient levels in soils as to maximize plant recovery and to minimize loss to the environment. Even with the best available matrix mathematics, all individual factors cannot be quantitatively evaluated for every single eventual possible field condition. The judgement of the farmer must come into play in exercising Best Management Practices (BMP's) for nutrient use in crop production. It was suggested that the following four BMP's for plant-nutrient use deserve special attention: (1) matching rate of application closely to the need of each soil-crop combination, (2) time of fertilizer application, (3) method of application, and (4) forms of nutrients relative to crop recovery and loss to the environment.

78:05G-071
BEST MANAGEMENT PRACTICES FOR AGRICULTURE AND SILVICULTURE,
Loehr, R.C., Haith, D.A., Walter, M.F., and Martin, C.S., Editors.
Cornell University, Ithaca, New York, College of Agriculture and Life Sciences.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, 154 fig, 159 tab, 490 ref, 57 equ.

Descriptors: Conferences, Water quality, Water pollution, Water quality control, Water pollution control, Water quality act, Federal water pollution control act, Water management (applied), Conservation, Wastes.

The papers presented at the 1978 Cornell Agricultural Waste Management Conference were grouped into the following catagories and published: Governmental aspects; Approaches for Best Management Practice (BMP) selection; Nutrient management; Silviculture; Economic, policy and institutional aspects; State and watershed approaches; and Modeling Studies. The emphasis for control of nonpoint pollution sources was placed upon the use of BMP's rather than on the collection, treatment and effluent standards approach used for control of point sources.

78:05G-072
USER'S MANUAL FOR AGRICULTURAL RUNOFF MANAGEMENT (ARM) MODEL,
Donigian, A.S., and Davis, H.H.
Hydrocomp Incorporated, Palo Alto, California 94304.
Publication No. EPA-600/3-78-080, August, 1978. 163 p, 16 fig, 25 tab, 33 ref, 3 append.

Descriptors: Agricultural runoff, Model studies, Computer models, Computer programs, Simulation analysis, Water pollution, Hydrologic budget, Sediment load, Pesticide residues, Nutrient removal.

This user manual provides detailed instructions and guidelines for using the Agricultural Runoff Management (ARM) Model, Versions I and II. The manual includes a brief general description of the ARM Model structure, operation, and components, but the primary purpose of this document is to supply information, or sources of information, to assist potential users in using, calibrating, and applying the ARM Model. Data requirements and sources, model input and output, and model parameters has been described and discussed. Extensive guidelines are provided for parameter evaluation and model calibration for runoff, sediment, pesticide, and nutrient simulation. Sample input sequences and examples of model output are included to clarify the tables describing model input and output. The manual also has discussed computer requirements and methods of analysis of the continuous information provided by the model. This manual, when used with an understanding of the simulated processes and the model algorithms, can provide a sound basis for using the ARM Model in the analysis of agricultural nonpoint pollution problems and management practices.

78:05G-073
POLLUTION CONTROL MANUAL FOR IRRIGATED AGRICULTURE,
Kepler, K., Carlson, D., and Pitts, W.T.
Toups Corporation, 1966 West 15th Street, Loveland, Colorado 80537.
Publication No. EPA-908/3-78-002, August, 1978. 213 p, 30 fig, 28 tab, 131 ref, 4 append.

Descriptors: Water pollution, Water quality, Water pollution control, Agriculture, Return flow, Salinity, Sediment, Nitrates, Pesticides, Water law, Salt balance.

The manual is intended to expand understanding of irrigated agriculture-water quality relationships to a broad group, including water quality interests, water resource interests, and agricultural field technicians. Information on collecting pertinent information on the irrigation system, sampling techniques, and evaluation techniques for determining the water quality impacts of return flows, combined with beneficial use aspects allow irrigation to be put into perspective with other elements of a water quality plan. Development of best management practices (BMP's) incorporate this water quality information plus information on the various agricultural practices. Understanding of local conditions affecting BMP's can be developed within the evaluation framework. Technical information on irrigated agricultural practices and the pollutants associated with return flows is presented in a thoroughly-organized manner which makes it available to the layman as well as to experienced personnel. Traditional and recently developed irrigation practices are developed and evaluated in terms of use, pollutant loading pathways, cost, and effectiveness. Pollutants are discussed in terms of occurence in nature, loading mechanisms, evaluation techniques, and effect upon beneficial use.

78:05G-074
AN EVALUATION OF THE POTENTIAL FOR USING DRAINAGE CONTROL TO REDUCE NITRATE LOSS FROM AGRICULTURAL FIELDS TO SURFACE WATERS,
Gilliam, J.W., Skaggs, R.W., and Weed, S.B.
North Carolina State University, Raleigh, Department of Soil Science, Agricultural Experiment Station.
Water Resources Research Institute Report No. 128, PB 280 575, January, 1978. 108 p, 23 fig, 4 tab, 32 ref, 3 append.

Descriptors: Nitrogen, Nitrates, Denitrification, Drainage water, Drainage effects, Oxidation-reduction potential, Agriculture, Water pollution, Return flow, Water pollution control.

The potential of drainage control to reduce the nitrate losses to surface waters from artificially drained agricultural fields was investigated. This research was an outgrowth of previous work which showed that considerable denitrification occurred in poorly drained soils with high water tables. This resulted in less nitrate leaving the fields in drainage waters than occurred in better drained soils. Two locations were selected for these experiments so as to cover a range of soil conditions representative of large areas of drained soils in the Coastal Plains of North Carolina. Flashboard riser type water control structures were installed in the four main tile lines or four collector ditches at each location. Drainage was allowed to proceed normally or was prevented until water table in the field reached any predetermined elevation. The experimental observation showed no significant change in nitrogen concentration of the drainage water under controlled and uncontrolled conditions. However, approximately 50% reduction in drainage discharge was observed under controlled conditions resulting in approximately 50% reduction in total nitrogen loss through drainage compared to uncontrolled conditions. It was concluded that it is potentially possible to reduce the average winter loss of nitrate-nitrogen under controlled drainage conditions.

78:05G-075
SALINITY MANAGEMENT OPTIONS FOR THE COLORADO RIVER,
Andersen, J.C., and Kleinman, A.P.
Utah State University, Logan, Utah Water Research Laboratory.
Water Resources Planning Series Report P-78-003, June, 1978. 344 p, 53 fig, 364 tab, 249 ref, 7 append.

Descriptors: Colorado River, Colorado River Basin, Salinity, Water quality, Water quality control, Water pollution, Economic impact, Linear programming, Return flow, Model studies.

The study sought to provide additional information to estimate 1) economic damages caused by various salt concentrations to agricultural and municipal water users and 2) economic costs of salinity control measures by upstream water users. Damages were estimated for high salinity levels to provide guidelines to project future conditions. Control costs were estimated with a physical model developed to predict the response of soil, water, and crop factors. Input-output models were used to estimate indirect economic impacts.

78:05G-076
CROPPING AN ABANDONED FEEDLOT TO PREVENT DEEP PERCOLATION OF NITRATE-NITROGEN,
Schuman, G.E., and Elliott, L.F.
United States Department of Agriculture, Agricultural Research Service, Route 1, Box 698, Cheyenne, Wyoming 82001.
Soil Science, Vol. 126, No. 4, p 237-243, October, 1978. 6 fig, 2 tab, 6 ref.

Descriptors: Nitrogen, Nitrates, Feed lots, Water pollution, Water quality, Water quality control, Groundwater, Leachate, Crop production, Nebraska.

An abandoned feedlot was cropped to corn (Zea mays L.) and alfalfa (Medicago sativa L.) to prevent excess buildup and deep percolation of NO3-N from the organic and NH4-N accumulations from the feedlot operation. To eliminate part of the N and salt accumulation, 15 cm of surface material was removed from half the plots and replaced with field soil. Alfalfa production was 14.1 and 11.8 metric tons/ha, and corn forage production was 8.0 and 6.7 metric tons/ha, from the intact surface and removed surface treatments, respectively. Nitrogen uptake was two and one-half to three times greater for alfalfa than for corn, which was reflected by the NO3-N content of the respective soil profiles. Nitrate-N content of the corn forage exceeded 2000 ppm (above the acceptable limit for livestock consumption), whereas the alfalfa averaged only 857 ppm, which would allow using it as a feed without ensiling. Nitrate buildup in the soil profiles was greater when the surface material remained in place; the results indicated that with proper cropping, however, either method would prevent excess NO3-N accumulation.

78:05G-077
GROUNDWATER CONTAMINATION BY FERTILIZER NITROGEN,
Duke, H.R., Smika, D.E., and Heermann, D.F.
United States Department of Agriculture, Fort Collins, Colorado 80521.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR3, p 283-291, September, 1978. 6 fig, 2 tab, 8 ref.

Descriptors: Water pollution, Water pollution control, Nitrogen, Fertilizers, Nitrates, Denitrification, Groundwater, Water quality, Return flow, Water management (applied), Leachate.

It was shown that excessive irrigation of the sandy soils to which center pivot sprinklers are adaptable can result in leaching of significant amounts of nitrogen fertilizer as NO3(-). Careful water management is an effective means of controlling NO3-N losses. The USDA irrigation scheduling program was used successfully to determine the timing and amount of irrigation necessary to maintain high crop yields yet minimize leaching losses. Although significant NO3-N losses were measured from fields in the study area, neither the fraction of that NO3(-) present in return flows nor the mechanism of possible denitrification had been identified. It was expected that if, in fact, significant denitrification occurred in the vicinity of the water table as the data suggested, the potential for groundwater pollution by leached nitrates is considerably reduced. Even so, careful water management was considered to be an important factor in the irrigation program as it affects efficiency of fertilizer utilization, cost of energy for pumping, and ultimately the yield of crops produced.

SECTION XXV

WATER RESOURCES AND PLANNING

TECHNIQUES OF PLANNING (GROUP 06A)

78:06A-001
IDENTIFICATION AND INITIAL EVALUATION OF IRRIGATION RETURN FLOW MODELS,
Walker, W.R.
Irrigation Hydrology Company, P.O. Box 1544, Fort Collins, Colorado 80522.
Publication No. EPA-600/2-78-144, July, 1978. 124 p, 3 fig, 4 tab, 160 ref, 6 append.

Descriptors: Mathematical models, Irrigation, Water resources, Water pollution, Water, Simulation, Prediction, Water quality, Soil water, Soil chemistry.

A broad based literature review was undertaken to identify studies that had yielded digital computer models applicable to irrigation return flow (IRF) systems. The programs not listed in technical reports or papers were requested from the various authors. The results of this work are 43 computer models applicable all or in part to the analysis of IRF's and their quality. A brief evaluation of each model is given. IRF modeling technology is well developed theoretically but not completely verified due to the large scale of the irrigation system. Most models remain in the research sphere and need to be redefined for the wider utilization of planners. Field data are generally not available to satisfy the input requirements of most IRF models. Accuracies of predictions need to be determined against standardized conditions in order to further model development and parameter sensitivities should be investigated to isolate the most important field data.

78:06A-002
MATHEMATICAL MODELING OF PESTICIDES IN THE ENVIRONMENT,
Hill, J. IV
Environmental Research Laboratory, United States Environmental Protection Agency, College Station Road, Athens, Georgia 30601.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 194-197. 24 ref.

Descriptors: Pesticides, Pesticide toxicity, Mathematical models, Environmental effects, Ecosystems, Model studies.

This paper recommends that research needs to be directed toward mathematical modeling that allows translation of laboratory measurements of pesticide effects on growth, physiology, and environmental interaction to field conditions. Further, it suggests that models need to be developed that estimate whole system behavior based upon data representing a limited set of component interactions. Hierarchial models with constrained subsystems and homomorphic structures derived from influence analysis may accomplish these goals in the near future.

78:06A-003
PREDICTING AND SIMULATING PESTICIDE TRANSPORT FROM AGRICULTURAL LAND: MATHEMATICAL MODEL DEVELOPMENT AND TESTING,
Bailey, G.W. and Nicholson, H.P.
Environmental Research Laboratory, United States Environmental Protection Agency, College Station Road, Athens, Georgia 30601.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 30-37. 26 ref.

Descriptors: Pesticides, Pesticide toxicity, Pollutants, Pollution abatement, Environmental effects, Computer models, Mathematical models, Simulation analysis, Small watersheds, Basins.

The transport of pesticides from agricultural lands and other compartments of the environment has generated public apprehension concerning the fate and effects of these compounds. Legislative mandates require guidelines to be developed covering pesticide use in order to prevent or minimize water pollution resulting from pesticide transport from agricultural land. Computer simulation models of the dynamic multiple rainfall-event type are being developed and refined to describe and predict quantitatively transport of pesticides from soil as a function of agricultural management practices, watershed characteristics, climatic factors, and properties of soils and pesticides. This paper discusses the steps involved in development, testing and verification of such models.

78:06A-004
TRANSIENT SUBSURFACE DRAINAGE ON SLOPING IRRIGATED LAND,
Yeh, H.J., and King, L.G.
Washington State University, Pullman, Department of Agricultural Engineering.
Paper No. 78-2037, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 21 p. 7 fig, 15 ref, 2 equ.

Descriptors: Subsurface drainage, Subsurface drains, Irrigated land, Canal seepage, Slopes, Interception, Numerical analysis, Water table, Irrigation, Hydrodynamics.

Parallel subsurface drains on sloping land were studied. Source of water was upslope seepage such as from a canal as well as intermittant irrigation over the drains. The ground surface was treated as a boundary so that both fully and partially saturated flow conditions existed within the soil region under study. The water table location was determined from the numerical solution of hydraulic head as a function of space coordinates. ADI methods were used to solve the basic partial differential equation together with appropriate initial and boundary values. Land slopes of up to 15 degrees from the horizontal were studied. Water table fluctuation and drain discharge were obtained over several irrigation cycles. During recession of the water table following an irrigation, the location of the maximum water table height between the drains moved toward the lower drain. The water table recession following an irrigation was compared with existing theories using only saturated flow for parallel drains on flat land. The results of this study showed the water table height as a function of time to be greater than predicted by existing theories even for quite small slopes. The effects of partially saturated flow and land slope on this result are discussed.

78:06A-005
INTERCEPTOR DRAINS ON SLOPING LAND,
Gharaaty-Sani, R., and King, L.G.
Washington State University, Pullman, Department of Agricultural Engineering.
Paper No. 78-2038, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 21 p. 11 fig, 2 tab, 21 ref.

Descriptors: Subsurface drains, Subsurface drainage, Interception, Canal seepage, Seepage control, Steady flow, Numerical analysis, Seepage, Flow rates, Water table.

A single subsurface drain intercepting seepage from an upslope source such as a canal was studied under steady flow conditions. Numerical methods were used to solve the nonlinear partial differential equation describing the two-dimensional problem with both partially and fully saturated flow occurring. Three different soils and three different depths of water in the canal were studied using this model. The resulting water table and drain discharge were compared with published theory based upon laboratory flume studies which neglected or minimized partially saturated flow. The published theory predicts water table shape and location adequately for design purposes; however, the drain discharge given by such theory is low (sometimes for fine textured soils, as low as fifty percent of that given by this study). Neglecting partially saturated flow could lead to undersized drains on sloping lands.

78:06A-006
DRAINAGE REQUIREMENTS FOR LOWLAND RICE,
Undan, R.C., Phillips, A.L., and Hill, R.W.
Utah State University, Logan, Department of Agriculture and Irrigation Engineering.
Paper No. 78-2041, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 21 p. 10 fig, 5 tab, 2 ref.

Descriptors: Drainage, Rice, Drainage effects, Submerged plants, Submergence, Rainfall, Simulation analysis, Computer models, Submerged vegetation stage, Construction costs.

Field experiments were conducted in the Philippines with the IR-30 variety to determine the effects of depth and duration of submergence on rice yields, and the data used with rainfall and other physical information as bases for developing guidelines for drainage system capacity selection.

78:06A-007
CENTER PIVOT IRRIGATION IN THE COLUMBIA BASIN OF WASHINGTON AND OREGON: DYNAMICS AND IMPLICATIONS,
Muckleston, K.W., and Highsmith, R.M.
Oregon State University, Corvallis, Department of Geography.
Water Resources Bulletin, Vol. 14, No. 5, p 1121-1128, October, 1978. 1 fig, 13 ref.

Descriptors: Irrigation, Sprinkler irrigation, Columbia River, Hydroelectric power, Institutions, Water law, Oregon, Washington, Social impact, Economic impact.

Impacts of center pivot irrigation in the Columbia Basin were reviewed. As of 1976, over 225,000 acres were being irrigated by center pivot units in a five-county area of the basin in Oregon and Washington. Most of the development took place since 1970. Dynamic application of center pivot technology altered the concept of irrigability in the study area, converting lands that were often rolling, sandy, and plagued by wind erosion from low grade grazing to productive irrigated units. This development was entirely by private enterprise, with large corporate farms accounting for much of the effort. Little prior comprehensive planning or coordination took place. When the circulation of water is altered on such a massive scale, however, unplanned impacts may be far reaching. In this case they include: 1) acceleration of the shift to high cost thermoelectric generation, 2) alteration of state institutions designed to allocate water, and 3) possible significant alterations of the socioeconomic fabric of small rural service centers.

78:06A-008
OPTIMAL OPERATION OF LARGE AGRICULTURAL WATERSHEDS WITH WATER QUALITY CONSTRAINTS,
Williams, J.R., and Hann, R.W., Jr.
Texas A & M University, College Station, Department of Civil Engineering.
Publication No. 96, April, 1978. 151 p, 7 fig, 16 tab, 50 ref, 127 equ.

Descriptors: Agricultural watersheds, Sediment yield, Phosphorus, Nitrogen, Runoff, Forecasting, Model studies, Routing, Water quality, Linear programming, Optimization.

Models were developed for predicting daily sediment, phosphorus, and nitrogen yields from small watersheds; routing the yields through large watersheds; and determining the optimal operating policy of the large watershed. The model for predicting daily sediment, phosphorus, and nitrogen was developed by refining existing models and building new ones when existing models were considered inadequate.

78:06A-009
NUMERICAL MODEL FOR SATURATED-UNSATURATED FLOW IN DEFORMABLE POROUS MEDIA 3. APPLICATIONS,
Narasimhan, T.N., and Witherspoon, P.A.
California University, Berkeley, Earth Sciences Division.
Water Resources Research, Vol. 14, No. 6, p 1017-1034, December, 1978. 46 fig, 1 tab, 26 ref, 14 equ.

Descriptors: Saturated flow, Unsaturated flow, Porous media, Deformation, Numerical analysis, Model studies, Computer models, Land subsidence, Soil water movement, Subsurface flow.

This is the third and conclusive part of a three-paper series and describes the application of a numerical model for saturated-unsaturated flow in deformable porous media. In all, ten illustrative examples were presented not only to demonstrate the validity of the method but also to highlight the fundamental unity that exists in the basic principles of the fields of hydrogeology, soil mechanics, and soil physics. The chosen examples involved such diverse phenomena as soil consolidation, infiltration, and drainage and generation of fluid pressures due to cyclic loading such as earthquakes.

78:06A-010
ON THE CHOICE OF THE "APPROPRIATE MODEL" FOR WATER RESOURCES PLANNING AND MANAGEMENT,
Rogers, P.
Harvard University, Cambridge, Massachusetts, Department of City and Regional Planning.
Water Resources Research, Vol. 14, No. 6, p 1003-1010, December, 1978. 4 fig, 6 tab, 14 ref, 36 equ.

Descriptors: Water resources, Water resources development, Planning, Management, Model studies, Computer models, Computer programs, Mathematical models, Operations research, Analytical techniques.

The use of symbolic models has become widespread in water resources planning and management. The operations research literature, however, gives little guide as to the choice of the most appropriate model for any situation. This paper outlined a method for comparing models of differing complexity applied to a given situation. The hypothesis that simpler models are more appropriate than more representative but more complex models were tested on two simple irrigation examples.

78:06A-011
THREE-DIMENSIONAL MODELING OF GROUNDWATER FLOW SYSTEMS,
Frind, E.O., and Verge, M.J.
Waterloo University, Waterloo, Ontario, Canada N2L 3G1, Department of Earth Sciences.
Water Resources Research, Vol. 14, No. 5, p 844-856, October, 1978. 15 fig, 3 tab, 30 ref, 15 equ, 1 append.
(See 78:04B-011)

78:06A-012
CLIMATE, SOIL AND VEGETATION 7. A DERIVED DISTRIBUTION OF ANNUAL WATER YIELD,
Eagleson, P.S.
Massachusetts Institute of Technology, Cambridge, Department of Civil Engineering.
Water Resources Research, Vol. 14, No. 5, p 765-776, October, 1978. 10 fig, 3 tab, 13 ref, 35 equ.
(See 78:02A-007)

78:06A-013
SOME PROPOSITIONS ABOUT IRRIGATION PROJECT AND SYSTEM MANAGEMENT,
Bottrall, A.F.
Overseas Development Institute, London, United Kingdom, Agricultural Administration Unit.
ICID Bulletin, Vol. 27, No. 2, p 68-72, July, 1978. 1 tab.

Descriptors: Water management (applied), Irrigation, Irrigation programs, Agriculture, Decision making, Management, Project planning, Irrigation design, Irrigation operation and maintenance, Crop production.

This is a modified version of a paper presented at the Overseas Development Institute Workshop on Choices in Irrigation Management, held from 27 September-1 October, 1976 at the University of Kent, Canterbury, (U.K.). The object of this paper is to put forward some generalized propositions about certain aspects of irrigation management in devoloping countries on which, whatever the characteristics of a particular project or system may be, strategic decisions will at some point have to be made. The propositions are concerned primarily with projects dependent on surface water delivery systems. The propositions advanced in this paper are derived primarily from observations made during field research in North West India and from the desk review of case studies in other parts of the developing world. The first set of propositions is concerned with the broader aspects of project organization and management, the second set with more detailed aspects of water delivery system design and operations. But there is clearly a large degree of interdependence between propositions in each set.

78:06A-014
ESTIMATING IMPACTS OF SILVICULTURAL MANAGEMENT PRACTICES ON FOREST ECOSYSTEMS,
Larson, F.R., Ffolliott, P.F., Rasmussen, W.O., and Carder, D.R.
Rocky Mountain Forest and Range Experiment Station, United States Department of Agriculture--Forest Service, Flagstaff, Arizona.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 281-294. 19 ref.

Descriptors: Forest management, Forestry, Ecosystems, Computer models, Simulation analysis, Land use, Planning, Water quality, Streamflow.

A family of computer simulation modules was described that would aid forest managers and land use planners estimate the impact of management activities on the natural resources of the forest ecosystem. This family, called ECOSIM, includes three general modules: FLORA for estimating responses of the forest overstory, herbaceous understory, and organic matter; FAUNA for evaluating animal habitats, carrying capacity, and population dynamics; and WATER for assessing streamflow yield, sedimentation, and chemical quality. A command system enables users to operate all modules through a common language written in straight forward user terminology. The design gives flexibility in representing management activities by operating selected modules interactively on an appropriate data base.

78:06A-015
SIMULATION OF STORMWATER RUNOFF AND SEDIMENT YIELD FOR ASSESSING THE IMPACT OF SILVICULTURE PRACTICES,
Li, R.M., Eggert, K.G., and Simons, D.B.
Colorado State University, Fort Collins, Department of Civil Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 295-307. 6 fig, 11 ref, 11 equ.

Descriptors: Watershed management, Water yield, Sediment yield, Forest management, Model studies, Simulation analysis, Storm runoff.

During the past two decades several watershed modeling techniques have been developed to allow the prediction of water and sediment yield. The estimation of infiltration, runoff and sediment yield are the major process components required for simulating watershed response. These process models, when based on sound physical reasoning are generally recognized as an important predictive tool in assessing the impact of land use and silviculture management schemes on the environment. Unfortunately, these models are often necessarily complex in formulation and require considerable expertise and computer time to achieve reasonable results. Therefore, although quite accurate, their complexity often seems to inhibit their utility. In order to generate an answer quickly and with reasonable expenditure, easier techniques such as the basin recharge method, the unit hydrograph and the Universal Soil Loss Equation are often used despite their deficiencies. The simple watershed model presented in this paper combines the advantages of a nonlinear, physically based approach with the utility of an interactive format.

78:06A-016
METHODOLOGY FOR DETERMINING THE OPTIMAL MIX OF BMPs AND AGRICULTURAL PRODUCTION MODIFICATIONS,
Heaney, J.P., and Ammon, D.C.
Florida University, Gainesville, Department of Environmental Engineering Sciences.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 649-664. 17 fig, 1 tab, 11 ref, 3 equ.

Descriptors: Wastes, Pollution abatement, Pollutants, Detention reservoirs, Sediment control, Linear programming, Model studies, Sediment discharge, Dairy industry, Water pollution.

A simple procedure for determining the optimal mix of upstream and downstream controls in an urban area was presented by Heaney and Nix (EPA-600/2-77-083, 1977). This procedure was extended to permit evaluation of agricultural areas. The main different between urban and agricultural problems is that the farmer may consider production modifications in response to an imposed restriction on pollutant discharge. A linear programming model was developed earlier by other research workers which allows one to determine the production adjustments that could be made on a dairy farm facing nutrient limitations. This model was coupled with information on Best Management Practices' effectiveness presented in another publication and was extended to evaluate waste management problems.

78:06A-017
USER'S MANUAL FOR AGRICULTURAL RUNOFF MANAGEMENT (ARM) MODEL,
Donigian, A.S., and Davis, H.H.
Hydrocomp Incorporated, Palo Alto, California 94304.
Publication No. EPA-600/3-78-080, August, 1978. 163 p, 16 fig, 25 tab, 33 ref, 3 append.
(See 78:05G-072)

SECTION XXVI

WATER RESOURCES PLANNING

EVALUATION PROCESS (GROUP 06B)

78:06B-001
AN ECONOMIC METHODOLOGY FOR EVALUATING "BEST MANAGEMENT PRACTICES" IN THE SAN JOAQUIN VALLEY OF CALIFORNIA,
Horner, G.L., Dudek, D.J., and McKusick, R.B.
Economics, Statistics, and Cooperatives Service, United States Department of Agriculture.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 369-393, May 15-18, 1978. 1 fig, 1 tab, 20 ref.

Descriptors: Return flow, Economic prediction, Water quality, Management, Environmental effects.

Section 208 of Public Law 92-500 (The Federal Water Pollution Control Act Amendments of 1972) requires the preparation of areawide waste treatment management plans. Agricultural related pollutants such as subsurface drainage water and irrigation tailwater containing nutrients, sediment and pesticides must be identified and procedures and methods to control such discharges specified. Under Section 208, the reduction of pollutants may be achieved by adopting a set of "best management practices" that could include varying economic incentives, establishing resource use controls and suggesting public resource investment. To determine the economic and environmental impact of "best management practices," a methodology must be derived that specifies the relationship of agricultural production practices to water and land quality and the economic cost and benefit of changing those practices. Such a methodology is being developed to systematically collect and organize physical and economic data, specify the physical and economic relationships and estimate the changes in agricultural production, income, employment and resource demands from proposed "best management practices."

78:06B-002
EVALUATION OF MEASURES FOR CONTROLLING SEDIMENT AND NUTRIENT LOSSES FROM IRRIGATED AREAS,
Fitzsimmons, D.W., Brockway, C.E., Busch, J.R., Conklin, L.R., and Long, R.B.
Idaho University, Moscow, Idaho Agricultural Experiment Station.
Publication No. EPA-600/2-78-138, July, 1978. 150 p, 51 fig, 82 tab, 59 ref.

Descriptors: Irrigation, Soil conservation, Water quality, Salinity, Economic analysis, Management.

Field studies were conducted in two southern Idaho areas to determine the effects of different management practices on the quality and quantity of the runoff from surface-irrigated fields. Pollutant removal systems (primarily mini-basins, vegetated buffer strips and sediment retention ponds) were installed at some of the study sites and evaluated to determine their effectiveness in removing sediment and other materials from return flows. The results indicate that water, sediment and nutrient losses from surface-irrigated areas can be greatly reduced or eliminated by the use of certain types of management practices and/or pollutant removal systems. Linear programming models were used to determine the economic impacts of using different types of practices to control surface runoff and sediment losses from model farms. The results indicate that sediment losses from surface-irrigated fields can be reduced by as much as 50 percent at modest cost. Elimination of surface runoff and sediment losses would require the use of sprinkler irrigation systems and would decrease net income by about 15%. Some of the overall impacts of pollutant losses from surface-irrigated areas were evaluated. The annual cost of removing sediment from canals and ditches in the Boise Valley was found to be about $20 per hectare. Irrigation return flows contribute to water quality problems in the Boise River and downstream in the Snake River.

78:06B-003
TOPOLOGICAL CLASSIFICATIONS OF DRAINAGE NETWORKS: AN EVALUATION,
Onesti, L.J., and Miller, T.K.
Indiana University, Bloomington, Department of Geography.
Water Resources Research, Vol. 14, No. 1, p 144-148, February, 1978. 3 fig, 2 tab, 17 ref.

Descriptors: Drainage, Channels, Geomorphology, Networks, Classification, Basins, Correlation analysis.

Channel networks for 103 drainage basins ranging in size from 0.65 to 199 sq km were classified according to 9 topologic systems ranging from Strahler's order and Shreve's magnitude to those recently derived by Werner and Smart. Correlation coefficients and coefficients of determination were calculated to test the relationship between these systems and (10) characteristics of drainage basins and stream channels. The results suggest that (1) network properties are closely associated with basin area and with other characteristics primarily determined by area, (2) the hydraulic variables are essentially unrelated to all topologic systems analyzed, and (3) certain newly proposed topologic systems are unrelated to all characteristics tested, including area.

78:06B-004
IMPACT OF ENERGY DEVELOPMENT ON GROUNDWATER,
The Task Committee on the Impact of Energy Development on Groundwater Resources of the Groundwater Hydrology Committee of the Hydraulics Division,
American Society of Civil Engineers, New York, New York.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY2, p 157-168, February, 1978. 3 fig, 4 tab, 4 ref, 1 append.

Descriptors: Groundwater resources, Energy, Hydrology, Hydrologic aspects, Oil, Gases, Coals, Oil shales, Nuclear energy.

Available information indicates that energy development in the U.S. will not soon deplete or degrade groundwater resources over widespread areas. Very acute effects may occur locally in the next few years, and many isolated, but serious, problems exist now. Impacts beyond about 1990 are difficult to anticipate because of uncertainties about developable energy resources, development economics and policies, and technological advancement. However, it seems likely that predicted energy development will cause further competition for both surface- and groundwater resources and that the consequent greater waste outputs will add to pollution impacts. These adverse impacts can be avoided or reduced by timely and comprehensive planning which also should serve to enhance potential beneficial impacts.

78:06B-005
DESCRIBING IRRIGATION EFFICIENCY AND UNIFORMITY,
On-Farm Irrigation Committee of the Irrigation and Drainage Division,
American Society of Civil Engineers.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, p 35-41, March, 1978. 3 fig, 11 ref, 6 equ, 1 append.

Descriptors: Irrigation efficiency, Uniformity coefficient, Standards, Irrigation, Soil moisture, Efficiencies, Distribution.

There is an urgent need for standardization of efficiency terms used in on-farm irrigation. The purpose of this paper is to provide meanings for several such terms to reduce the vagueness and resulting confusion that now exists. The committee hopes these definitions will be accepted as standards, thus reducing conflicting usage and the consequent need for redefinition each time such terms are used. Only terms applicable to on-farm irrigation practices are presented, although many may be usable for larger units such as irrigation districts or basin wide projects.

78:06B-006
COMPUTER PROGRAMMING SOLID SET SYSTEMS,
Griffin, S.G.
The Toro Company, Riverside, California.

Paper No. 78-2012, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 9 p.
(See 78:03F-058)

78:06B-007
ECONOMICS OF IRRIGATION,
Sheffield, L.F.
Nebraska University, Lincoln, Department of Agricultural Economics.
Proceedings of The Irrigation Association, Stouffer's Towers, Cincinnati, Ohio, p 76-90, February 26-28, 1978. 5 fig, 7 tab.

Descriptors: Sprinkler irrigation, Economic prediction, Economic impact, Irrigation, Irrigated land, Cost analysis, Agriculture, Corn belt, Great Plains.

This paper reviews and discusses the accelerated growth of irrigated agriculture with center pivot irrigation systems in the Great Plains Region in the 1970's, and the reasons behind the severity and widespread effects of the current cost-price squeeze on farmers and agri-business community. A detailed analysis of the economics of irrigation leads to the conclusion that irrigated agriculture and the irrigation industry in the United States faces a bright future despite its present temporary problems.

78:06B-008
PREDICTING YIELDS,
Haun, J.R.
Clemson University, South Carolina, Department of Horticulture.
Crops and Soils Magazine, Vol. 31, No. 2, p 7-9, November, 1978. 3 fig.
(See 78:02I-035)

78:06B-009
DETERMINATION OF OPTIMAL WELL CAPACITIES FOR CONTINUOUS IRRIGATION PROGRAMS,
Sanghi, A.K., Johnson, D., and Kuepper, G.
Washington University, St. Louis, Missouri, Center for the Biology of Natural Systems.
CBNS-AE-9, NSF/RA-78-0017, January, 1978. 50 p, 11 fig, 17 tab, 18 ref, 2 append, 11 equ.

Descriptors: Water management (applied), Irrigation programs, Model studies, Wells, Evapotranspiration, Net profit, Economic prediction, Growth stages, Timing, Groundwater.

A method was developed to predict optimal and acceptable suboptimal well capacities using a model developed at the University of California, Davis. Net revenue values were calculated at various well capacities using a budget for a 132-acre field and an equation for determining yield reduction. The well capacities were chosen based on growth periods found to have a differential impact on corn yields. These differential effects were discussed in terms of the optimal and suboptimal well capacities that will fulfill water requirements through certain parts of the growth season. This model may provide a farmer with a predictive tool so that he may consider optimally timed water application by an optimal well capacity to maximize net revenue. In addition, it may provide information for policy makers to enact regulations, which would make the use of groundwater resources more beneficial to the society.

78:06B-010
SOCIAL COSTS AND EFFECTIVENESS OF ALTERNATIVE NONPOINT POLLUTION CONTROL PRACTICES,
Alt, K.F., Miranowski, J.A., and Heady, E.O.
Economics, Statistics, and Cooperatives Service, United States Department of Agriculture, Ames, Iowa.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 321-327. 1 tab, 11 ref.

Descriptors: Water pollution control, Water quality control, Water pollution, Social aspects, Cost comparisons, Cost-benefit analysis, Alternative costs, Social impact, Environmental control.

A study was undertaken to estimate the magnitude of the farm production cost adjustments that would result from implementing specific environmental policies in an intensively cropped river basin of about 940,000 acres in East-Central Iowa. A linear programming model was used to simulate the crop growing and erosion management activities of the area. An exponential abatement cost function resulted for the total cost of reducing the sedimentation rate of a reservoir at the mouth of the watershed. Some of the pollution control policies considered in the study did not restrict the farmer's choice to that particular crop management system which was most effective from an engineering standpoint. It was concluded that the choice of future pollution control policies needs to be based on the costs changes incurred by farmers as well as the administration and surveillance costs incurred by the public agency which administers the pollution policy, and therefore, a truly optimal choice among alternative pollution control policies can only be made when the total of all public and private costs is weighed against the total of all benefits received.

78:06B-011
THE ECONOMIC IMPLICATIONS OF EROSION AND SEDIMENTATION CONTROL PLANS FOR SELECTED PENNSYLVANIA DAIRY FARMS,
White, G.B., and Partenheimer, E.J.
Cornell University, Ithaca, New York, Department of Agricultural Economics.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 341-357. 6 tab, 8 ref.

Descriptors: Erosion control, Sediment control, Economic impact, Dairy industry, Water law, Soil conservation, Linear programming, Pennsylvania.

Amendments to the Clean Streams Law of Pennsylvania required the state's agricultural landowners to have erosion and sedimentation control plans implemented by July 1, 1977. The purpose of this research was to investigate the effects of implementation on the income of commercial dairy farms. The research focused on conservation plans made by the Soil Conservation Service (SCS) for twelve case study farms. Linear programming was used to estimate returns to fixed resources and farm organization for three plans for each farm. These included the base plan, before implementation of the SCS plan; the farm plan incorporating SCS recommendations; and a plan incorporating no-till corn production as an alternate or supplement to other conservation practices.

78:06B-012
FARM-LEVEL ECONOMIC EVALUATION OF EROSION CONTROL AND REDUCED CHEMICAL USE IN IOWA,
McGrann, J.M., and Meyer, J.
Iowa State University, Ames, Department of Economics.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 359-372. 1 fig, 3 tab, 11 ref.

Descriptors: Erosion control, Fertilizers, Pesticide toxicity, Water pollution sources, Economic impact, Model studies, Linear programming, Terracing, Institutional constraints, Iowa.

This study concentrated on the farm-level economic impact of soil loss control and reduced chemical use. The farms analyzed are typical of three major soil associations in Iowa which cover a wide spectrum of farming conditions in the state. The analysis investigated the impact of restricting soil loss from the present to several reduced levels on net farm income and land rents for both specialized crop and mixed crop and livestock farms. The waste disposal problem of the limited sized livestock enterprises was not addressed in this study. A limited analysis was made of the effect that reducing fertilizer and banning pesticide use would have on farm income as an alternative to reduce nonpoint pollution. Policy alternatives to control erosion, including tax rates to achieve reduced soil loss and cost-sharing schemes for terracing, were evaluated in farm-level models. Consideration was also made as to how information generated in the study can be used for extensionist and farmer training.

78:06B-013
ECONOMIC IMPACTS OF POLICIES TO CONTROL EROSION AND SEDIMENTATION IN ILLINOIS AND OTHER CORN-BELT STATES,
Seitz, W.D., Osteen, C., and Nelson, M.C.
Illinois University, Urbana, Institute for Environmental Studies.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 373-382. 10 ref.
(See 78:05G-058)

78:06B-014
PROCEDURE FOR ECONOMIC EVALUATION OF BEST MANAGEMENT PRACTICES,
Dempster, T.H., and Stierna, J.H.
United States Department of Agriculture, Soil Conservation Service, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 383-391. 1 fig, 1 tab, 3 ref.

Descriptors: Soil conservation, Soil erosion, Management, Economic impact, Environmental effects, Water pollution, Water pollution control, Water quality, Water quality control.

Evaluation procedures for best management practices (BMP) were discussed with emphasis on alternative practices affecting water conservation and quality, and production efficiency. Onsite and offsite resource problems that were identified and measured, include those related to reduced agricultural production and increased production and maintenance costs per unit of output which can result from erosion, sedimentation, impaired water quality and reduced soil moisture. Quantified data from the use of universalt soil loss equation, research studies of extension, universities and Agricultural Research Services (ARS), and compiling of experienced crop yields were evaluated with computerized methods such as the Crop Budget System (CBS), linear programming and value of agricultural production. CBS is a system designed for efficient storage, rapid retrieval, use and revision of crop budgets used to evaluate alternative systems of BMP. Qualifying statements on nonmonetary impacts, primarily environmental issues, were also discussed. Procedures describing the estimation of installation, operation and maintenance costs of BMP were included, as well as methods to assess income foregone and adverse environmental effects.

78:06B-015
AN ECONOMIC ANALYSIS OF EROSION CONTROL OPTIONS IN TEXAS,
Reneau, D.R., and Taylor, C.R.
Texas A & M University, College Station, Department of Agricultural Economics.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 393-418. 4 fig, 8 tab, 11 ref.

Descriptors: Erosion control, Soil erosion, Economic impact, Sediment control, Water pollution, Water pollution control, Water quality, Water quality control, Model studies, Texas.

A model for estimating the changes in farming practices, farm income, soil loss, off-site sediment damages, and social welfare over a long planning horizon for a watershed under various nonpoint source control options was presented. The model was sufficiently general to permit the study of several possible nonpoint source control options, including: (a) per acre soil loss limits; (b) soil loss taxes; (c) conservation practice cost sharing arrangement; and (d) combinations thereof. On-farm economics of conservation was imbedded in the model. Results from this modeling approach for Lavon Reservoir Watershed were presented. Included were the esimated changes in farming practices, farm income, soil loss, and off-site sediment damages for the selected nonpoint source control options.

78:06B-016
MODELING SOIL AND WATER CONSERVATION PRACTICES,
Beyerlein, D.C., and Donigian, A.S.
Hydrocomp, Incorporated, Palo Alto, California.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 687-713. 9 fig, 4 tab, 16 ref, 5 equ.
(See 78:05G-065)

78:06B-017
MODELING NUTRIENT EXPORT IN RAINFALL AND SNOWMELT RUNOFF,
Haith, D.A., and Tubbs, L.J.
Cornell University, Ithaca, New York, Departments of Agricultural Engineering and Environmental Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 665-685. 3 fig, 11 tab, 22 ref, 19 equ.

Descriptors: Nutrient removal, Agricultural watersheds, Mathematical models, Agricultural runoff, Model studies, Snowmelt, Water quality, Water pollution, New York.

Several mathematical models are available for the prediction of nutrient losses from agricultural watersheds. Most models have complex structures, require large computer programs and data banks and must be calibrated using streamflow data. There are obvious advantages, at least for planning purposes, in simpler modelling approaches with modest data and computational requirements. One such approach, which was evaluated in this paper, is the estimation of runoff from each unit source area within a watershed, multiplication of these runoff estimates by appropriate nutrient concentrations and summing the resulting mass fluxes for all source areas in the watershed. The approach is roughly equivalent to a distributed watershed model in which all flows are instantaneously routed to the watershed outlet. Mass fluxes of dissolved nitrogen, dissolved phosphorus and total phosphorus from agricultural runoff were estimated for each storm during a period of 18 months in 1972-1974 for the Fall Creek Watershed in upstate New York. The nutrient flux estimates were compared with measured nutrient exports from the watershed determined from water quality samples.

78:06B-018
MATHEMATICAL MODELING OF WATER QUALITY EFFECTS OF AGRICULTURAL BEST MANAGEMENT PRACTICES,
Tang, C.
URS Company, Seattle, Washington.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 625-647. 6 fig, 5 tab, 5 ref.
(See 78:05G-066)

78:06B-019
EVALUATION OF CONTROLS FOR AGRICULTURAL NONPOINT SOURCE POLLUTION,
Wineman, J.J., Walker, W., Kuhner, J., Smith, D.V., and Ginberg, P.
Meta Systems, Incorporated, Cambridge, Massachusetts.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 599-624. 8 fig, 5 tab, 10 ref.

Descriptors: Water quality, Methodology, Assessments, Model studies, Alternative planning, Water pollution, Water quality control, Evaluation.

A proposed methodology for assessing the water quality and socioeconomic impacts of agricultural practices was described and tested in a case study based on corn belt farming in northeastern Indiana. The potential use of the methodology to evaluate agricultural nonpoint source pollution control policies and the effects of alternative futures was illustrated. The development of such a methodology for state level planning appeared feasible and to be of significant value for broad analyses of large numbers of policy alternatives, including identification of Best Management Practices. However, the methodology was at a preliminary stage of development when this report was presented.

78:06B-020
WATER QUALITY MODELING IN THE DELAWARE COASTAL PLAIN REGION,
Ritter, W.F., and Jensen, P.A.
Delaware University, Newark, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 507-524. 7 fig, 3 tab, 24 ref.

Descriptors: Agricultural runoff, Model studies, Water quality, Water pollution, Nitrogen, Simulation analysis, Storm runoff, Nitrogen cycle, Coastal Plains, Delaware.

A study of nonpoint modeling and the effect nonpoint sources have on water quality was conducted for the Coastal Sussex County 208 Water Quality Program. The EPA Agricultural Runoff Model was used in conjunction with a one dimensional water quality model of eleven parameters (NH-N, NO2-N, NO3-N, phytoplankton-N, benthic N, herbivore N, particular organic N, dissolved organic N, ultimate BOD, dissolved oxygen and total coliform) to analyze the effects of land use changes on water quality. The ARM Model and water quality model were used in Indian River Bay, Little Assawoman Bay, Rehoboth Bay and the Broadkill River. The ARM Model gave satisfactory results for nitrogen and phosphorus nonpoint source loads. A simulation study indicated that there would be no major water quality effects resulting from 20 year projected increases in urban areas or other land use changes.

78:06B-021
METHODOLOGIES FOR VALUATION OF AGRICULTURAL CROP YIELD CHANGES--A REVIEW,
Leung, S., Reed, W., Cauchois, S., and Howitt, R.
Eureka Laboratories, Incorporated, 401 N. 16th Street, Sacramento, California 95814.
Publication No. EPA-600/5-78-018, August, 1978. 167 p, 5 fig, 3 tab, 433 ref.

Descriptors: Crop production, Economic impact, Economic prediction, Yield equations, Model studies, Methodology, Reviews, Pollutants, Air pollution, Agriculture.

This research effort was initiated with the objective to complete a review and evaluation of the methodological and analytical techniques used to assess and quantify the economic impact of changes in agricultural crop yields. The review focused on two major areas: (1) physical effects of man-made and natural factors on agricultural crop yield, and (2) methodologies and models used to evaluate and quantify the economic impacts of crop yield changes on the farm, the agricultural industry and finally the consumers. The major natural environmental factors included in this report are climate and weather, soil and biological conditions. Air pollution was the main consideration under the man-made factors. Three alternative models were identified for the evaluation of the cost to an individual farm due to changes in crop yield. These models are (a) mathematical optimization model, (b) simulation model, and (c) econometric model. Also outlined were the regional input-output model and the regional spatial programming model as two feasible approaches in evaluating the secondary economic impacts. Finally, the market supply and demand theories were identified as relevant concepts in analyzing the overall impacts on consumers due to crop yield changes.

78:06B-022
AN EVALUATION OF THE POTENTIAL FOR USING DRAINAGE CONTROL TO REDUCE NITRATE LOSS FROM AGRICULTURAL FIELDS TO SURFACE WATERS,
Gilliam, J.W., Skaggs, R.W., and Weed, S.B.
North Carolina State University, Raleigh, Department of Soil Science, Agricultural Experiment Station.
Water Resources Research Institute Report No. 128, PB 280 575, January, 1978.
108 p, 23 fig, 4 tab, 32 ref, 3 append.
(See 78:05G-074)

SECTION XXVII

WATER RESOURCES PLANNING

COST ALLOCATION, COST SHARING, PRICING/REPAYMENT (GROUP 06C)

78:06C-001
DRAINAGE INSTALLATION EQUIPMENTS "ECONOMICS OF THE ART",
Marsee, C.W.
Speicher Corporation, Celina, Ohio.
Paper No. 78-2527, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 9 p.

Descriptors: Drainage, Subsurface drains, Equipment, Trenches, Installation, Costs, Return (monetary), Investment, Economics.

There are two objectives being brought out of the "Economics of the Art" on Drainage Equipment. First, to make the drainage contractor more aware of his cost of operation and his return on investment. Second, to illustrate the cost of operation and return on investment between the wheel and chain trenching machines.

78:06C-002
SOCIAL OVERHEAD CAPITAL COSTS OF IRRIGATION DEVELOPMENT IN WASHINGTON STATE,
Whittlesey, N.K., Gibbs, K.C., and Butcher, W.R.
Washington State University, Pullman, Department of Agricultural Economics.
Water Resources Bulletin, Vol. 14, No. 3, p 663-678, June, 1978. 2 fig, 4 tab, 7 ref.

Descriptors: Irrigation, Energy, Social impact, Costs, Washington, Irrigation effects, Water resources development, Columbia river.

Increased irrigation as a means of achieving economic development can impose significant social costs on the state or region of growth. The growth in population induced by additional irrigation will require roads, water and sewage facilities, schools, fire and police protection, etc. Also the increased energy demands due to irrigation and growth in economic activity must be met. Capital investments required to service these needs of new development can become very large. This study attempted to measure such social overhead costs or irrigation development for some specific irrigation project areas of Eastern Washington. It was shown that investment costs in overhead items can reach $2,000 per acre irrigated or $70,000 per job created. Alternatively, the annual costs can equal $180 per acre or $6,700 per worker. These costs must be paid locally through increased taxes, utility rates, or costs for services.

SECTION XXVIII

WATER RESOURCES PLANNING

WATER DEMAND (GROUP 06D)

78:06D-001
REMOTE SENSING OF AGRICULTURAL WATER DEMAND INFORMATION: A CALIFORNIA STUDY,
Estes, J.E., Jensen, J.R., and Tinney, L.R.
California University, Santa Barbara, Department of Geography.
Water Resources Research, Vol. 14, No. 2, p 170-176, April, 1978. 3 fig, 3 tab, 8 ref.

Descriptors: *Remote sensing, *Water demand, *Computer models, *Groundwater basins, *California, Agriculture, Crops, Statistics, Prediction, Simulation analysis.

This study focuses on the use of LANDSTAT image-processing techniques to produce cropland and crop type statistics for input into agricultural water demand prediction procedures currently being employed by the Kern County Water Agency in Kern County, California. The potential of remote sensing to provide input to the Kern County Water Agency's groundwater basin model in a more accurate and timely fashion is the objective of the research discussed herein. Current accuracies associated with LANDSTAT cropland/noncropland identifications are of the order of 98% absolute accuracy. These data are being operationally incorporated into model calculations on a quarterly basis. Crop specific accuracies, although somewhat lower, are steadily being improved, and prospects for eventual incorporation appear good. The model, which divides the San Joaquin Valley floor portion of the Kern County groundwater basin into 251 nodal regions, is designed to produce a total simulation of water transmission and storage throughout the model area; it incorporates detailed, relatively stable geologic information in conjunction with the capabilities provided by remote sensing, the potential exists to sample current information continually for both short-term and long-term agricultural water demand forecasting.

78:06D-002
ANALYSIS OF WATER REQUIREMENTS FOR AGRICULTURAL IRRIGATION IN PENNSYLVANIA,
Kibler, D.F., Fritton, D.D., White, E.L., Trotter, R.J., and Tandy, D.F.
Pennsylvania State University, University Park, Institute for Research on Land and Water Resources.
Research Publication 99, September, 1977, 228 p. 28 fig, 35 tab, 6 ref.

Descriptors: *Crop production, *Climates, *Irrigation water, *Soil moisture, *Water demand, *Water requirements, *Pennsylvania, Irrigation, Application methods, Crops.

The objective is to identify the crops which are likely to be irrigated under Pennsylvania's climatic conditions. The decisions are made on the basis of the historical use of irrigation for crops as documented in census records and on the basis of published irrigation research experiments and other carefully documented investigations which apply. The attempt is to base decisions on documented yield increases of a crop under irrigated conditions when compared to yields produced by natural rainfall. The specific purpose of this investigation has been to develop quantitive estimates of expected irrigation demand by analyzing the frequency distribution of rainfall, effective precipitation and soil moisture deficit as they vary by crop and location throughout the State. Frequency analysis of these irrigation parameters is based upon an extensive data base describing the hydrologic, climatologic, and agronomic conditions found at 65 potential irrigation sites located in the primary agricultural areas of the State. All data were analyzed by computer methods to obtain frequency estimate of soil moisture deficit by crop and region. The soil moisture deficit is a primary indicator of irrigation need which can be used to project future irrigation demands in Pennsylvania.

SECTION XXIX

WATER RESOURCES PLANNING

WATER LAW AND INSTITUTIONS (GROUP 06E)

78:06E-001
WESTERN WATER LAWS AND IRRIGATION RETURN FLOW,
Radosevich, G.E.
Resources Administration and Development, Incorporated, P.O. Box 1028, Fort Collins, Colorado 80522.
Publication No. EPA-600/2-78-180, August, 1978. 257 p, 5 fig, 3 tab, 107 ref, 1 append.

Descriptors: Water law, Water rights, Irrigation, Irrigated land, Water pollution, Water quality.

The impact of water law upon allocation and use of waters within the Western United States is currently recognized as one of the major constraints to adaptation by irrigated agriculture of more efficient operation practices. This project provides a background of the law and evaluation of the potentials through water law interpretations or changes to implementing improved water management technology. Specifically, this report provides a synthesis of water laws of each of the 17 western states, as well as providing a state-by-state account of the water quantity laws, paying particular attention to features in the laws and their administration that direct the manner of use and provide incentives or disincentives to more efficient use. General recommendations are offered that will permit or induce more efficient and effective water management. Specific recommendations identify areas requiring additional research to renovate state water laws consistent with present and prospective policies and needs.

78:06E-002
ALTERNATIVE POLICIES FOR CONTROLLING NONPOINT AGRICULTURAL SOURCES OF WATER POLLUTION,
Seitz, W.D., Gardner, D.M., Gove, S.K., Guntermann, K.L., and Karr, J.R.
Illinois University, Urbana-Champaign, Urbana, Illinois 61801.
Publication No. EPA-600/5-78-005, April, 1978. 314 p, 22 fig, 55 tab, 168 ref, 8 append.

Descriptors: Water pollution, Soil erosion, Economics.

This study of policies for controlling water pollution from nonpoint agricultural sources includes a survey of existing state and Federal programs, agencies, and laws directed to the control of soil erosion. Six policies representing a variety of approaches to this pollution problem are analyzed. The aggregate economic impact of such policies is investigated using a state-of-the-art, market-equilibrium, linear-programming model of crop production in the corn belt. The economic effects of the policies at the level of individual forms and their impacts on long-term soil productivity are analyzed through the use of a watershed model. The institutional arrangements needed to implement the policies are examined, as are the associated costs for a typical county. Literature on the social aspects of policy acceptance is reviewed, and the results of a survey of the reaction of farmers and ASCS directors in Illinois to different policies are presented. The equity of the policies is examined and legal precedents are reviewed.

78:06E-003
AN ANALYSIS OF PLAYA LAKE WATER UTILIZATION ON THE TEXAS HIGH PLAINS,
Templer, O.W.
Texas Tech University, Lubbock, Department of Geography.
Water Resources Bulletin, Vol. 14, No. 2, p 454-465, April, 1978. 3 fig, 34 ref.

Descriptors: Water utilization, Playas, Texas, Semi-arid climates, Water rights, Water law, Groundwater recharge, Runoff, Groundwater, Irrigated land.

This paper examines the spatial, temporal and legal aspects of playa lake water utilization on the semi-arid Texas High Plains. These small basins of interior drainage collect and briefly hold an estimated two to three million acre-feet of runoff water annually, representing from one-fourth to one-third the quantity of groundwater pumped from the dwindling Ogallala aquifer. Once considered a detriment to farming operations, there is now increased interest in using playa water more effectively. At present direct pumping is the chief method of utilization, and modification of lake bottoms to concentrate runoff and reduce evaporation is the most widespread conservation practice. The use of playa water for groundwater recharge is hampered by as yet unsolved technical problems. For many years, the question of ownership of playa water remained unsettled. The Texas Water Rights Commission now classes it as diffused surface water, which under Texas law may be used by the landowner, though some legal problems remain. For playa lakes to be effectively integrated into the regional water resource it becomes imperative that all present and prospective water utilization problems be identified and resolved.

78:06E-004
208 WATER QUALITY PLANNING HOW IT WILL AFFECT YOU,
Humenik, F.J.
North Carolina State University, Raleigh, United States Department of Agriculture.
Irrigation Journal, Vol. 28, No. 3, p 6-7, 17, 24, 25, May-June, 1978.

Descriptors: Water law, Water pollution control, Water pollution, Water pollution sources, Waste water disposal, Waste water treatment, Water quality act, Water quality control, Water resources planning act, Planning.

208 is actually a section of Public Law 92-500, the Federal Water Pollution Control Act Amendment of 1972. General goals of this sweeping legislation are to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. A comprehensive discussion of "Section 208" is presented in this article.

78:06E-005
NON-POINT POLLUTION AND THE SCS,
Agricultural Engineering, Vol. 59, No. 5, p 19-20, May, 1978.

Descriptors: Water pollution, Water pollution sources, Water pollution control, Water quality act, Pollution abatement, Soil conservation, Legal aspects, Agricultural engineering.

Agricultural Engineering interviews Glen H. Loomis, PE, director of the Environmental Services Division of USDA-SCS, on the Culver Amendment to the Clean Water Act.

78:06E-006
INTERNATIONAL PROBLEMS,
Holburt, M.B.
Values and Choices In the Development of The Colorado River Basin, The University of Arizona Press, Tucson, Arizona, 1978, p 220-237. 2 fig, 1 tab, 11 ref.

Descriptors: Colorado River, Colorado River Basin, Water quality act, Water quality, Water quality control, Water pollution control, Mexican Water Treaty, Legislation, Salinity.

This paper discusses the Colorado River water quality and quantity problems between the United States and Mexico, considerations that have led to the several agreements between the two countries, and possible future actions.

78:06E-007
THE LEGALIZATION OF GROUNDWATER STORAGE,
Gleason, V.E.
Southern California Metropolitan Water District, Los Angeles.
Water Resources Bulletin, Vol. 14, No. 3, p 532-541, June, 1978. 1 fig, 16 ref.

Descriptors: *Water law, *Water rights, *Appropriative rights, *California, *Water storage, Legal aspects, Aquifer management, Judicial decisions, Groundwater, Water supply.

California courts recently recognized underground aquifer storage rights that allow public agencies to store imported waters in aquifers, to prevent others from expropriating that water, and to recapture that water when it is needed. The two appellate decisions representing the common-law development of aquifer storage rights are discussed. One decision, entitled Niles Sand and Gravel Company vs. Alameda County Water District 37 C.A. 3d 924 (1974), involved an aquifer managed under statutory authority, while the other, City of Los Angeles vs. City of San Fernando 14 Cal. 3d 199 (1975), dealt with an aquifer managed under judicial authority. These decisions offer two rationales for aquifer storage rights: (1) to protect water supplies necessary for the overlying community, and (2) to increase water supply efficiency by using natural underground storage whenever possible. This paper analyzes the relationship between aquifer storage rights and conventional groundwater rights, indicating aspects of storage rights that need further development.

78:06E-008
A PROGRAM TO PROMOTE IRRIGATION CONSERVATION IN IDAHO,
Hammond, J.
State of Idaho, Statehouse, Boise, Department of Water Resources.
Pacific Northwest Regional Commission, March, 1978. 43 p, 6 fig, 12 ref.
(See 78:03F-107)

78:06E-009
NORTH CAROLINA 208 CASE STUDY,
Horney, L.F., Koehler, F.A., and Bliven, L.F.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Paper No. 78-2584, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 6 p. 4 ref.

Descriptors: Water pollution, Water quality, Water pollution control, Water quality control, Planning, Water management (applied), Water law, Legislation, Agriculture, North Carolina.

The North Carolina approach for the development of the agricultural portion of the statewide 208 plan has been influenced by unanswered questions concerning actual water quality and relationships between agricultural practices, conservation techniques and areawide water quality. The planning organization and responsibilities, approaches and studies undertaken leading to plan recommendations were discussed in this paper.

78:06E-010
NONPOINT SOURCE POLLUTION CONTROL STRATEGY,
Groszyk, W.S.
Water Planning Division, United States Environmental Protection Agency, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 3-10.

Descriptors: Water pollution control, Water pollution, Water quality, Water quality control, Federal water pollution control act, Water quality act, Water law, Management.

This paper discussed the two major elements of the U.S. Environmental Protection Agency's nonpoint source (NPS) pollution control strategy, and how two amendments in the Clean Water Act of 1977 provide with additional ways to implement NPS control programs, and thus solve some of the critical water quality problems. These two major elements of EPA's nonpoint source control program were described to be: (1) to accelerate the implementation of NPS control programs and the application of Best Management Practices (BMP's) and, (2) to focus the available resources on solving the most severe problems first. This paper discussed these elements in details.

78:06E-011
RESEARCH NEEDS AND CURRENT ACTIVITIES,
Murphy, T.A.
Office of Research and Development, United States Environmental Protection Agency,
Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 25-30.

Descriptors: Water pollution, Water quality control, Water management (applied), Soil conservation, Water conservation, Management, Federal project policy, Mathematical models, Environmental control.

This paper focused on broad topics regarding the renewable resources industry, including the current concerns, issues, and emerging environmental problems. The role of EPA in agricultural research was discussed in terms of both the nature and extent of our activities, within the context of cooperation with the agribusiness community. Reliance on typical soil and water conservation measures as best management practices for maintenance of water quality was viewed from the perspective of present technical knowledge and system assessment capabilities. Additional studies necessary to confirm the link between water quality and best management practices were suggested. It was suggested that improved monitoring techniques, instream water quality surveys, and a better understanding of sediment/pollutant adsorption and desorption mechanisms are required in the near future to sharpen the guidelines for establishing agricultural nonpoint source management systems. Needed area-wide pollution problem assessment methodologies, BMP field evaluation, mathematical modeling of transport phenomena, and predictive techniques for BMP system comparisons were outlined. The projected extent of EPA/ORD involvement in these future activities was examined in light of potential resource availability and was compared with similar activities in other Federal, State, and local agencies and institutions.

78:06E-012
CONSERVATION DISTRICT INVOLVEMENT IN 208 NONPOINT SOURCE IMPLEMENTATION,
Williams, R.E., and Lake, J.E.
National Association of Conservation Districts, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 57-67.
(See 78:05G-048)

78:06E-013
MANAGEMENT AND FINANCING OF AGRICULTURAL BMPs,
Rice, J.M.
URS Company, Seattle, Washington.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 329-340. 2 fig, 1 tab, 5 ref.

Descriptors: Water quality control, Water quality, Water pollution, Planning, Management, Agricultural runoff, Water pollution sources, Water pollution control, Programs, Washington.

One of the major goals of the Section 208 areawide waste management planning program, mandated by PL 92-500 and administered by the U.S. Environmental Protection Agency (EPA), is to develop solutions to identified water pollution problems which can and will be put into practice. The agricultural program developed in SNOMET/King County (Washington) represents one approach to implementing nonpoint water pollution control measures which both satisfies the technical and other requirements of EPA concerning water quality management and satisfied the more pragmatic requirements of working farmers who are concerned both about making a living and about conservation. This paper presented the results of that program with special emphasis on unique aspects of the social and political setting of the SNOMET/King County area. The implemented program is in one sense no different than those developed in many other agricultural areas of the country; yet its acceptance by the local farming community and their willingness to participate in implementation of the program represent an institutional achievement in itself. Process, not product, then was a major focus of this paper.

78:06E-014
THE POLICY RELEVANCE OF ALTERNATIVE INSTITUTIONAL APPROACHES TO 208 PLANNING,
Hamilton, A., and Libby, L.W.
Michigan State University, East Lansing, Department of Agricultural Economics.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 419-428. 4 tab, 3 ref.

Descriptors: Water quality control, Water quality act, Water pollution, Planning, Decision making, Alternative planning, Water quality, Local governments.

The power to implement many of the best management practices to control nonpoint pollution being considered in 208 planning lies with local governments (county, city, town, village). But the planning for reduction of nonpoint sources of pollution, is being done at the regional (usually multi county) of the state level. The tradeoffs between coordination and implementation that occur at these two different institutional boundaries were examined in this paper. It was believed that this research will have relevance not only to the water quality planning process but to a number of other planning exercises as well. The paper has drawn preliminary conclusions on the policy relevance of the different planning models discussed.

78:06E-015
ECONOMIC, INSTITUTIONAL AND WATER QUALITY CONSIDERATIONS IN THE ANALYSIS OF SEDIMENT CONTROL ALTERNATIVES: A CASE STUDY,
Sharp, B.M.H., and Berkowitz, S.J.
Wisconsin University, Madison, Department of Agricultural Economics.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 429-453. 6 fig, 8 tab, 20 ref, 6 equ.

Descriptors: Sediment control, Economic impact, Institutional constraints, Water quality, Linear programming, Soil conservation, Sediment yield, Sediment load, Model studies, Decision making.

Traditional economic analyses of the impact of conservation policies on the farm firm have relied solely upon the establishment of soil loss constraints to induce compliance. There are, however, different approaches to inducing a pattern of behavior which are also consistent with achieving the desired reduction in sediment. These policy options also have differing economic, institutional and water quality implications. The results of a study, conducted in a 440 acre watershed in Washington County, Wisconsin, which explicitly recognizes a set of institutional alternatives designed to modify operator behavior, were presented in this paper. In addition, the water quality implications of these alternatives with respect to sediment loads were illustrated.

78:06E-016
INSTITUTIONAL AND TECHNICAL ASPECTS OF THE DEVELOPMENT OF AGRICULTURAL BMPs IN A FIVE-COUNTY RURAL/URBAN MICHIGAN REGION,
Jones, J.P., and Sutherland, J.C.
Williams & Works, Incorporated, Grand Rapids, Michigan.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 455-462. 2 fig.
(See 78:05G-059)

78:06E-017
DEVELOPMENT OF A "208 PLAN" FOR AGRICULTURAL NONPOINT POLLUTION SOURCES IN ILLINOIS,
Vanderholm, D.H., Frank, J.F., and Taylor, A.G.
Illinois University, Urbana-Champaign, Department of Agricultural Engineering.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 563-580.
(See 78:05G-061)

78:06E-018
APPROACH FOR ANALYZING AND MANAGING AGRICULTURAL NONPOINT SOURCES IN THE STATE OF MARYLAND,
Schoenhofer, R.F., Knight, W.A., and Hancock, C.V.

Water Resources Administration, State of Maryland Department of Natural Resources, Annapolis, Maryland.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 551-561. 2 fig, 9 ref.
(See 78:05G-062)

78:06E-019
A STATE PERSPECTIVE ON NONPOINT SOURCE MANAGEMENT,
Berle, P.A.
New York State Department of Environmental Conservation, Albany, New York.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 17-24.
(See 78:05G-068)

78:06E-020
IMPROVING WATER QUALITY IN AGRICULTURE AND SILVICULTURE,
Unger, D.G.
Agriculture for Conservation, Research and Education, United States Department of Agriculture, Washington, D.C.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 11-16.

Descriptors: Water pollution, Water quality, Water quality control, Water pollution control, Water law, Water management (applied), Programs, Federal water pollution control act, Federal project policy, Federal government.

This paper reports the viewpoints of U.S. Department of Agriculture on America's water quality needs and the programs designed to meet them. It was stressed that the overall job of upgrading water quality requires an effective combination of good management, technical assistance, economic incentives, research and education.

78:06E-021
POTENTIAL EFFECTS OF ENVIRONMENTAL POLICIES ON RESOURCE USE AND REGIONAL INCOMES IN AGRICULTURE,
Vocke, G.F., and Heady, E.O.
Iowa State University of Science and Technology, Ames, Iowa.
Agriculture and Environment, Vol. 4, No. 2, p 99-109, August, 1978. 1 fig, 6 tab, 8 ref.

Descriptors: Agriculture, Crop production, Economics, Environment, Fertilizers, Land management, Land resources, Land use.

The results of this study indicate that U.S. agriculture can comply with restrictive environmental policies but not without significant consequences for farmers and their incomes. The imposition of a soil conservation policy alters crop production patterns, changes the regional distribution of agricultural incomes, and implies higher food expenses for consumers. A restriction on the use of nitrogen fertilizer requires substantial substitutes of other resources to maintain agricultural output. However, regional production patterns are altered, thus changing regional incomes from agriculture. A ban on the use of the organochlorine insecticides Chlordane and Haptachlor causes few major changes for agriculture but there is the potential that the incomes of some Midwest corn farmers may be drastically reduced by an insect infestation. Requiring feedlot operators to control the runoff from their feedlots will be particularly costly for small livestock producers but does not significantly alter regional livestock production patterns. Under high exports which are not restrained by environmental measures, land used for crops increases by 67 million acres, fertilizer use increases by 29 percent, and pesticide expenditures increase by 50 percent. When the several environmental restrictions are applied simultaneously, the value of exports must decline by 40 percent. Accompanying the reduction in exports is a 60 percent decline in soil erosion and a 30 percent reduction in nitrogen use.

SECTION XXX

WATER RESOURCES PLANNING

ECOLOGICAL IMPACT OF WATER DEVELOPMENT (GROUP 06G)

78:06G-001
IRRIGATION MANAGEMENT SERVICE AND MOSQUITO CONTROL,
Hayes, R.O., and Nielsen, R.L.
Colorado State University, Fort Collins, Vector-Borne Diseases Division, Center for Disease Control.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR2, p 153-163, June, 1978. 1 fig, 2 tab, 19 ref, 1 append.

Descriptors: Irrigation programs, Mosquitoes, Irrigation practices, Vectors (biological), Diseases, Disease resistence, Water management (applied), Crop production, Water pollution, Irrigated land.

The importance of irrigation to the production of agricultural crops has led to its widespread use throughout the United States. Mosquito production and vector-borne diseases often have been problems in intensely irrigated areas, but in some areas good irrigation water management practices have been shown to minimize such problems. The evaluation of the Mesa County, Colorado, Irrigation Management Service (IMS) program found it associated with lower site and habitat infestation rates only among the IMS orchard sites, whereas the IMS program was not associated with reduced mosquito production among either alfalfa or corn fields, and no mosquito production was found associated with sugar beet crops, either in or out of the IMS program. Although pastures were not included in the IMS program, they were included in this evaluation, and a high percentage of the pastures examined were associated with mosquito production. The results also revealed that the mosquito fauna, the principal types of mosquito larval habitats, and the water sources for mosquito breeding in the irrigated areas of Mesa County were nearly the same in 1975 as in 1959.

78:06G-002
AGRICULTURE AND CONSERVATION--ECOLOGICAL AND SOCIAL ASPECTS,
Hampicke, U.
Agriculture and Environment, Vol. 4, No. 1, p 25-42, April, 1978. 70 ref.

Descriptors: Agriculture, Conservation, Ecology, Social aspects, Political aspects, Pesticides, Planning, Economic impact.

The technological features and the economic and political repercussions were discussed of an agricultural system which would meet strict conservation requirements in central Europe, should they exist. The rate and number of species losses, classification of endangered species and destruction of environmental variety were discussed. It was suggested that the countryside be divided systematically into areas of high productivity, and others where traditional methods of land use are continued. Three possibilities for protecting ecologically valuable regions were discussed: abolishing the use of pesticides, etc. altogether; improved methods of crop spraying to prevent spray falling onto adjacent areas; and adaptation to unavoidable spray scattering by spatial structuring, i.e., installing buffer areas between productive and protected zones. With regard to the political and economic consequences of such a system, three indispensable prerequisites were identified: an adequate system of value judgments in society; sufficient economic flexibility to allow changes; and proper means of coordination, i.e., economic planning. It was concluded that gradual improvements on a local scale are possible and should be encouraged.

78:06G-003
ENVIRONMENTAL AND INSTITUTIONAL ASPECTS OF IRRIGATION AGRICULTURE,
van Schilfgaarde, J.
U.S. Salinity Laboratory, Riverside, California.

Paper No. 78-2045, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 6 p. 7 ref.

Descriptors: Irrigation, Salinity, Drainage, Institutional constraints, Environmental effects, Social aspects, Irrigated land, Irrigation design, Water management (applied), Agriculture.

Irrigation agriculture requires drainage, but design options and water management choices impact not only agricultural production. A host of institutional and societal considerations affect the viability of technically feasible alternatives. Drainage, as an integral part of water management, must be viewed within this larger framework and options identified that optimize total resource use.

SECTION XXXI

RESOURCES DATA

NETWORK DESIGN (GROUP 07A)

78:07A-001
LEARNING TO IRRIGATE. . .WITH 5000 TENSIOMETERS,
Henry, C.
Irrigation Age, Northwest/Pacific Editor.
Irrigation Age, Vol. 13, No. 3, p 6-8, November-December, 1978. 4 fig.

Descriptors: Tensiometers, Scheduling, Irrigation, Idaho.

This article reports the experience of an irrigation consultant with the use of tensiometers for irrigation scheduling.

78:07A-002
PREDICTING IRRIGATION RETURN FLOW RATES,
Bondurant, J.A., Brockway, C.E., and Brown, M.J.
United States Department of Agriculture-Science and Education Administration, Brawley, California.
Transactions of the American Society of Agricultural Engineers, Special Edition, Vol. 21SW, No. 6, p 1142-1143, December 20, 1978. 2 fig, 2 tab, 4 ref, 1 equ.

Descriptors: Return flow, Sediment load, Sediment distribution, Streamflow, Design flow, Irrigation.

Return flows from irrigated areas in southern Idaho were analyzed and a relationship was developed that characterizes flows by relating the cummulative percent of total seasonal flow to maximum flow rate. Since maximum flow rate can be estimated from channel characteristics and flow evidence, it was suggested that design flow rates' sediment ponds can be selected where flow records are not available.

78:07A-003
SPATIAL VARIABILITY OF SOLUBLE SALT CONTENT IN A MANCOS SHALE WATERSHED,
Wagenet, R.J., and Jurinak, J.J.
Utah State University, Logan, Department of Soil Science and Biometeorology.
Soil Science, Vol. 126, No. 6, p 342-349, December, 1978. 4 fig, 2 tab, 11 ref, 4 equ.

Descriptors: Salinity, Saline water, Saline soils, Spatial distribution, Colorado River Basin, Water quality, Sampling, Statistical methods, Soil chemical properties.

A study was conducted to examine data collected in the microwatershed land process studies with regard to quantifying spatially variable soil properties. All 35 sampling sites were classified as occurring on the Mancos shale formation within a 777 sq km (300 sq mi) area of the Price River Basin. Samples were taken at 0-2.5, 2.5-7.5, and 7.5-15.0-cm depths. Using the electrical conductivity (EC) of either the 1:1 or saturation extract as the salinity index parameter, it was found that EC values were distributed log-normally about the mean EC value of 35 observations. The coefficient of determination for the log-normal statistical plots was 1.00 for all three depths sampled at the 35 sites. The variance in the EC values increased with depth.

SECTION XXXII

RESOURCES DATA

DATA ACQUISITION (GROUP 07B)

78:07B-001
ASSEMBLY FOR MOUNTING HYDRAULIC SOIL CORE SAMPLER ON TRACTOR FRONT,
Ginn, L.H., Heatherly, L.G., and Russell, W.J.
United States Department of Agriculture, Agricultural Research Service, Stoneville, Mississippi.
Soil Science Society of America Journal, Vol. 42, No. 3, p 512-514, May-June, 1978. 4 fig, 6 ref.

Descriptors: Cores, Sampling, Soil types, Hydraulic equipment.

A front-mounted tractor assembly for support of a hydraulic soil core sampler was constructed. The design satisfies requirements for rapid soil or root core sampling. An essential part of the assembly is a tool bar which allows lateral movement of the mounted core sampler. The assembly with mounted sampler is capable of extracting 1.9 to 10.2-cm diameter cores to depths as great as 125 cm throughout a 102-cm lateral path.

78:07B-002
IMPROVED TECHNIQUES FOR MARKING AND SAMPLING BAND-APPLIED FERTILIZERS AND PESTICIDES,
Hendrickson, L.L., Keeney, D.R., Lesczynski, D.B., and Walsh, L.M.
Wisconsin University, Madison, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 3, p 507-508, May-June, 1978. 1 fig, 1 tab, 10 ref.

Descriptors: Nitrification, Inhibitors, Sampling, Marking, Techniques, Nitrogen compounds.

Techniques for marking and sampling banded fertilizers were developed to estimate the rate of nitrification and the recovery of N from the band treated with a nitrification inhibitor. The band was marked by applying prilled elemental S at the point of fertilizer application. The sampler was constructed of stainless steel and was 15 by 15 by 40 cm long. It was inserted into the soil above the previously located band and then removed and disassembled, and the soil subsectioned for a vertical profile of constituents in the band. The expanded dimensions of the sampler reduced sample variability, yet still allowed sufficient sampling efficiency to obtain adequate replication. These techniques provided more accurate estimates of nitrification and recovery of applied N and should find application in monitoring other fertilizers or pesticides on easily penetrated soils devoid of rocks.

78:07B-003
COLORIMETRIC DETERMINATION OF UREA IN SOIL EXTRACTS USING AN AUTOMATED SYSTEM,
Douglas, L.A., Sochtig, H., and Flaig, W.
Melbourne University, Australia, School of Agriculture and Forestry.
Soil Science Society of America Journal, Vol. 42, No. 2, p 291-292, March-April, 1978. 1 fig, 1 tab, 2 ref.

Descriptors: Ureas, Colorimetry, Analytical techniques, Inhibitors, Soil tests, Automation.

A method is described for using an automated system to determine urea in 2M KCl soil extracts that contain a urease inhibitor (phenylmercuric acetate). The method is sensitive and precise and allows 90-120 extracts to be analyzed per day.

78:07B-004
A NEW APPROACH TO SOIL TESTING: III. DIFFERENTIAL ADSORPTION OF POTASSIUM,
Stout, W.L., and Baker, D.E.
Pennsylvania State University, University Park, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 2, p 307-310, March-April, 1978. 1 fig, 7 tab, 17 ref, 10 equ.

Descriptors: Soil tests, Potassium, Cation adsorption, Nutrient requirements, Cation exchange, Soil chemical properties, Regression analysis.

Donnan type ratios were used to develop an index to account for the differential adsorption of K in two widely different soils of the Rayne and Hublersburg series. This index was used to calculate an adjusted K requirement for the soils using the approach of Baker. Three corn hybrids (Zea mays L.) were grown in the two soils treated with different levels of K and multiple regression analysis was used to relate soil test variables to plant K content. Most of the variation in the index, K sub E/S, was associated with soil effects, making the index useful in characterizing the two soils with respect to differential K adsorption and in calculating soil K requirements. Over 60% of the variation in plant K content was explained by the soil K requirement calculated from the index. Compared with a critical K level of 98 ppm exchangeable K for soils with a CEC of 10 mez/100 g and a K sub E/S of 1.0, the comparable critical values for K were 71 ppm for the Rayne and 114 ppm for the Hublersburg.

78:07B-005
QUANTITATIVE ESTIMATION OF LIVING WHEAT-ROOT LENGTHS IN SOIL CORES,
Ward, K.J., Klepper, B., Rickman, R.W., and Allmaras, R.R.
Columbia Plateau Conservation Research Center, Pendleton, Oregon, United States Department of Agriculture.
Agronomy Journal, Vol. 70, No. 4, p 675-677, July-August, 1978. 4 tab, 5 ref.

Descriptors: Root development, Wheat, Dicots, Monocots, Sampling, Cores.

A rapid, efficient method for separating living wheat (Triticum aestivum L.) roots from dead roots in field soil samples has been proposed. Combined techniques of separation, staining and length measurements were used to determine root density with an accuracy of ±9%. It was observed that most monocot roots stained more intensely than dicot roots, indicating that monocot-dicot root separation from the same root medium may facilitate studies of root competition.

78:07B-006
MEASURING SYMBIOTIC NITROGEN FIXATION IN RANGELAND PLOTS OF TRIFOLIUM SUBTERRANEUM L. AND BROMUS MOLLIS L.,
Phillips, D.A., and Bennett, J.P.
California University, Davis, Department of Agronomy and Range Science and Vegetable Crops.
Agronomy Journal, Vol. 70, No. 4, p 671-674, July-August, 1978. 3 fig, 1 tab, 16 ref.

Descriptors: Nitrogen fixation, Range grasses, Legumes, Clovers, Range management, Symbiosis, Isotop studies.

The 15N A-value technique and the acetylene reduction method were compared for their accuracy in determining seasonal symbiotic N2 fixation on a ground area basis in rangeland plots of Trifolium subterraneum L. and Bromus mollis L. To simulate range management practices, seeds were planted at 10, 141, or 1970 seeds/sq m in pure stands of 50:50 mixtures in Laughlin loam, a member of the fine-loamy, mixed, mesic family of Ultic Haploxerolls. Amounts of N2 fixed, calculated by the 15N A-value technique, varied significantly with planting density and proportion of clover at different densities. Seasonal, symbiotic N2 fixation, calculated from the acetylene reduction method, did not vary significantly with either planting density or proportion of clover. It is concluded that with appropriate studies on possible differences in isotope accumulation by a grass and a legume, including morphological, physiological, and bio-chemical differences, the 15N A-value technique should be more quantitative and discriminatory than the acetylene reduction technique. The single seasonal sampling requirement of the 15N A-value technique also is more amenable to the overall goal of determining the effect of range management systems on symbiotic N2 fixation.

78:07B-007
RELATIONSHIP BETWEEN LEAF AREA AND DRY MATTER IN WINTER WHEAT,
Aase, J.K.
Northern Plains Soil and Water Research Center, P.O. Box 1109, Sidney,
Montana 59270.
Agronomy Journal, Vol. 70, No. 4, p 563-565, July-August, 1978. 3 fig, 14 ref.

Descriptors: Wheat, Leaves, Plant growth, Growth stages, Montana.

Models of plant growth and plant water use often require leaf-area measurements, a potentially time-consuming and costly process. The objective of this study was to determine if by establishing a relationship between leaf area and dry matter in winter wheat (Triticum aestivum L. em Thell), that dry matter can be substituted for leaf area. Four cultivars of winter wheat were seeded on Dooley sandy loam and Williams loam (fine-loamy, mixed, Typic Argiborolls) in northeastern Montana in three divergent growing seasons. Leaf area and dry matter determinations, from random 30-cm row plant samples cut at ground level, were made weekly throughout the season. Leaf area and leaf dry matter were closely correlated (coefficient of determination = 0.951). Leaf area vs. plant dry matter also was closely correlated (coefficient of determination = 0.948) through the fifth growth stage (leaf sheaths strongly erect, tillering complete). Thus it appears that in studies and modeling efforts where leaf area indices are needed, at least for winter wheat, leaf dry matter may be substituted for leaf area index.

78:07B-008
THE AUTOMATIC DETERMINATION OF ppb LEVELS OF AMMONIA, NITRATE PLUS NITRITE, AND PHOSPHATE IN WATER IN THE PRESENCE OF ADDED MERCURY (II) CHLORIDE,
Skjemstad, J.O., and Reeve, R.
Commonwealth Scientific and Industrial Research Organization, St. Lucia,
Queensland 4067, Australia, Division of Soils.
Journal of Environmental Quality, Vol. 7, No. 1, p 137-141, January-March, 1978.
4 fig, 3 tab, 17 ref.

Descriptors: Ammonia, Nitrates, Nitrites, Phosphates, Preservation, Chemical analysis.

Three automated procedures are reported for the simultaneous determination of ammonia, nitrate plus nitrite, and phosphate in water. The ammonia determination is based on the salicylate-dichloroisocyanurate reaction in the presence of nitroprusside preceded by in-line distillation. Nitrate plus nitrite is estimated by using an in-line copperized cadmium reductor, diazotizing the nitrite with sulphanilamide, and coupling with N-1-naphthylethylenediamine. Phosphate is estimated by reaction with molybdate and reduction to molybdenum blue with ferrous ammonium sulphate. Mercury (II) chloride used as a preservative does not interfere with the methods and good precision at ppb levels can be obtained.

78:07B-009
A NEUTRON ACTIVATION METHOD FOR DETERMINING SUBMICROGRAM SELENIUM IN FORAGE GRASSES,
Cook, K.A., and Graham, E.R.
Missouri University, Columbia, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 1, p 57-60, January-February, 1978. 1 fig, 5 tab, 7 ref.

Descriptors: Fescues, Forage grasses, Neutron activation analysis, Radiochemical analysis, Irradiation.

Neutron activation as a method for the analysis of submicrogram amounts of Se in fescue and orchard leaves was evaluated. It was observed that the Se content of National Bureau of Standards orchard leaves was 0.078 ppm compared with the NBS reported value of 0.080 ppm Se. The relative standard deviation for the orchard leaves was found to be 5.3%. Following irradiation and nitric-perchloric acid digestion, Se was extracted from a 4M HBr solution using benzene containing 1% phenol. The method is sufficiently sensitive to measure with accuracy 0.010 ppm Se in 0.250 g of material. The method is straightforward and accurate and requires the extraction of Se in benzene which is completely free of phosphorus.

78:07B-010
SODIUM BICARBONATE EXTRACTION TO ESTIMATE NITROGEN, PHOSPHORUS, AND POTASSIUM AVAILABILITY IN SOILS,
Bar-Yosef, B., and Akiri, B.
Division of Soil Chemistry and Plant Nutrition, Bet Dagan, Israel, The Volcani Center.
Soil Science Society of America Journal, Vol. 42, No. 2, p 319-323, March-April, 1978. 6 fig, 3 tab, 8 ref, 2 equ.

Descriptors: Soil analysis, Soil chemical properties, Soil tests, Nitrogen, Phosphorus, Potassium, Calcareous soils, Sodium compounds, Nutrients.

The extractability of NO3-N, P, and K from five calcareous soils differing in physical and chemical characteristics by NaHCO3 (0.5M, pH 8.5) was studied under laboratory conditions. The extracted amounts of the three ions were related to time since their application to the soils, to the equilibration period of the soils with the extractants, to the concentration of the ions in the soils, and to the clay content of the soils. After about 70 days in the soil, the extractability of each ion at a given application level was independent of time. The recovery percentage of P and K as a function of the applied amounts of these elements depended mainly on the clay content of the soils, while NO3-N recovery was independent of the factors studied. Linear relationships were obtained between NaHCO3- and NH4OAC-extracted K, and NaHCO3- and KCl-extracted NO3-N. The slopes for NO3-N were 45 degrees for all soils, but were specific for each soil in the case of K.

78:07B-011
NEW FLUME BREAKTHROUGH FOR DITCH IRRIGATORS,
Clemmens, A.J., and Replogle, J.A.
United States Water Conservation Laboratory, Science and Education Administration, Phoenix, Arizona.
Irrigation Age, Vol. 12, No. 7, p 82-88, April, 1978. 3 fig, 3 tab.

Descriptors: Flumes, Equipment, Open channel flow, Flow measurement, Cost analysis, Cost comparisons, Critical flow, Ditches, Irrigation, Arizona.

New design methods for critical-flow flumes installed in open channels make on-farm flow measurement simple, accurate, and inexpensive. This paper describes the methods and construction procedures used in developing a new flume to measure water flow in open channels. The cost analysis of the eight flumes tested shows that the cost of the flume is very inexpensive compared with other types of flumes. It also claims to be precise within ±2%.

78:07B-012
DEVELOPMENT OF A DTPA SOIL TEST FOR ZINC, IRON, MANGANESE, AND COPPER,
Lindsay, W.L., and Norvell, W.A.
Colorado State University, Fort Collins, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 421-428, May-June, 1978. 4 fig, 7 tab, 31 ref.

Descriptors: Chelation, Soil tests, Spectrophotometry, Nutrients, Fertilizers, Sweet corn, Sorghum, Colorado.

A DTPA soil test was developed to identify near-neutral and calcareous soils with insufficient available Zn, Fe, Mn, or Cu for maximum yields of crops. The extractant consists of 0.005M DTPA, 0.1M triethanolamine, and 0.01M CaCl2, with a pH of 7.3. The soil test successfully separated 77 Colorado soils on the basis of crop response to Zn, Fe, and Mn fertilizers. Development of the soil test was based, in part, on theoretical considerations. The extractant is buffered at pH 7.30 and contains CaCl2 so that equilibrium with CaCO3 is established at a CO2 level about 10 times that of the atmosphere. Thus, the extractant precludes dissolution of CaCO3 and the release of occluded nutrients which are normally not available to plants. DTPA was selected as the chelating agent because it can effectively extract all four micronutrient metals. Factors such as pH, concentration of chelating agent, time of shaking, and temperature of extraction affect the amount of micronutrients extracted and were adjusted for maximum overall effectiveness.

78:07B-013

A RAPID METHOD FOR ESTIMATING THE NITROGEN-SUPPLYING CAPABILITY OF A SOIL,
Fox, R.H., and Piekielek, W.P.
Pennsylvania State University, University Park, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 5, p 751-753, September-October, 1978. 2 fig, 1 tab, 8 ref.

Descriptors: Nitrogen, Nutrient requirements, Fertilization, Nutrients, Crop response, Corn (field), Correlation analysis, Estimating, Data collections.

Nitrogen fertilizer recommendations in humid regions have been primarily based on crop N requirements without regard for the variability in the N-supplying capability of the soil. The authors found (reported in a separate article) that two previously proposed N availability indexes, 0.01M $NaHCO_3$ and boiling 0.01M $CaCl_2$ extractable N, were well correlated ($r=0.77$ and 0.86, respectively; $P < 0.01$ for both) with the capability of eight Pennsylvania soils to supply N to field grown corn, (Zea mays L.) However, the time and expense required for these analyses may preclude their routine use by soil testing laboratories. In seeking ways to shorten and simplify the analyses, it was found that the ultraviolet (UV) absorption by the 0.01M $NaHCO_3$ soil extract at 260 nm was as well correlated with the N-supplying capability of the test soils ($r=0.865$ $P < 0.01$) as the best of the previously evaluated extractable N indexes. This new method is as rapid, simple, and inexpensive as the methods currently used to measure availability of other essential nutrients in the soil. It was also demonstrated how this method can be used to predict more accurately the fertilizer N needs for corn.

78:07B-014

GREENHOUSE EVALUATION OF RESIDUAL PHOSPHATE BY FOUR PHOSPHORUS METHODS IN NEUTRAL AND CALCAREOUS SOILS,
Bowman, R.A., Olsen, S.R., and Watanabe, F.S.
Colorado State University, Fort Collins, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 451-454, May-June, 1978. 3 fig, 3 tab, 32 ref, 2 equ.

Descriptors: Phosphorus, Chemical analysis, Soil chemical properties, Calcareous soils, Carriers, Greenhouses.

Four determinations of phosphorus--Olsen P, Colwell-P, total exchangeable P, and resin-extractable P--were evaluated in terms of total plant P uptake in a 3-year continuous greenhouse study of 23 high P calcareous and neutral soils. All methods were highly correlated with the total P taken up from the soils by 5-8 successive greenhouse crops. The Olsen-P procedure extracted an average of nearly 50% of the total plant P while the colwell procedure extracted nearly 80%. Resin-extractable P and total exchangeable P values approximated the total plant P uptake, and served as good biological measures of the total plant-available P in the soil. No significant differences were observed between the carrier and carrier-free ^{32}P methods on the 23 tests soils.

78:07B-015

AN INEXPENSIVE PRECIPITATION GAUGE,
Buchanan, B.A., DeVelice, R.L. and Urquhart, N.S.
New Mexico State University, University Park, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 3, p 532-533, May-June, 1978. 2 fig, 2 ref.

Descriptors: *Rain gages, *Design, *Equipment, Precipitation (atmospheric), Rainfall, Measurement, Instrumentation, Gages, Arid lands, Meteorology.

An inexpensive, yet accurate, precipitation gauge was developed from readily available materials. The gauge accurately estimated precipitation as measured by a standard Weather Bureau gauge for 35 precipitation events in a one-year period. This inexpensive gauge has been used successfully in the field for two years.

78:07B-016

PESTICIDE TRANSPORT AND METABOLISM IN MODEL SYSTEMS,

Kaufman, D.D., Kearney, P.C., and Nash, R.G.
Pesticide Degradation Laboratory, Beltsville, Maryland 20705.
In: Symposium on Environmental Transport and Transformation of Pesticides, October, 1976, Tbilis, USSR. EPA-600/9-78-003, February, 1978, Athens, Georgia, p 61-72. 6 fig, 2 tab, 14 ref.

Descriptors: Pesticides, Pesticide kinetics, Pesticide residues, Metabolism, Assay, Soil microbiology, Microbial degradation, Sorption, Ecosystems, Laboratory tests.

Laboratory studies devoted to investigating the environmental fate of pesticides have usually examined individual processes such as microbial metabolism, soil leaching, surface and vapor phase photodecomposition, volatilization from plant or soil surfaces, and plant uptake. In the environment, however, all of these processes may be operative on the molecule, so that in each stage of the pesticide dissipation process, one or more processes may play a major role. It has been extremely difficult to study two or more of these processes under controlled conditions which will enable a clear understanding of the contribution of each. Simplified model laboratory systems are now being developed which enable simultaneous measurement of numerous factors affecting pesticide dissipation in the environment. This paper is a discussion of a few model laboratory systems.

78:07B-017

RAPID DETERMINATION OF SOIL WATER CHARACTERISTIC BY THERMOCOUPLE PSYCHROMETRY,

Riggle, F.R., and Slack, D.C.
Minnesota University, St. Paul, Department of Agricultural Engineering.
Paper No. 78-2026, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 24 p. 6 fig, 1 tab, 34 ref, 4 equ.

Descriptors: Soil water, Moisture content, Moisture tension, Soil moisture, Soil properties, Moisture availability, Soil tests, Drying, Irrigation, Osmotic pressure.

A procedure was developed for determination of the soil water characteristic curve with thermocouple psychrometry. Complete soil water characteristic curves were obtained for a Nicollet clay loam, a Waukegan silt loam, and a Hubbard sandy loam within one week in ambient air conditions. The curves obtained by the psychrometer method compared favorably with those obtained by pressure methods.

78:07B-018

THE SPECTROPHOTOMETRIC AND FLUOROMETRIC DETERMINATION OF ALUMINUM WITH 8-HYDROXYGUINOLINE AND BUTYL ACETATE EXTRACTION,

Bloom P.R., Weaver, R.M., and McBride, M.B.
Minnesota University, St. Paul, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 713-716, September-October, 1978. 2 fig, 3 tab, 11 ref.

Descriptors: Aluminum, Chemical analysis, Analysis, Spectrophotometry, Fluorometry, Acidic soils, Solvent extractions, Organic matter.

A spectrophotometric method and a fluorometric method for the determination of Al by the extraction of the Al-hydroxyquinolate complex with butyl acetate were evaluated. The Al complex was found to be very stable in butyl acetate. The spectrophotometric method was found to be useful for the analysis of solutions containing 50 ppb Al or greater. The spectrophotometric response was linear up to absorbance = 1.1. The relative error in midrange was <2.5%. The quantity of Al determined in soil extracts was shown for some soils to be strongly dependent on the time of contact with the complexing reagents before extraction with butyl acetate. This was attributed to the complexation of Al by organic matter in the soil solutions. The fluorometric method was found to have a detection limit of about 0.3 ppb Al. The fluorometric response was nearly linear in the most sensitive range of the fluorometer but was less linear for higher Al concentrations. The relative error was <8% except near the detection limit. There was no interference with either method from Na(+), K(+), Mg(2+), Ca(2+), Sr(2+), Ba(2+), Fe(2+), Fe(3+), F(-), PO4(3-), SO4(2-), and SO3(2-) at the levels found in most soil extracts.

78:07B-019
ELECTRON PROBE MICROANALYTICAL STUDIES OF PHOSPHORUS DISTRIBUTION WITHIN SOIL FABRIC,
Qureshi, R.H., Jenkins, D.A., and Davies, R.I.
Agricultural University, Lyallpur, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 698-703, September-October, 1978. 4 fig, 13 ref.

Descriptors: Phosphorus, Chemical analysis, Soil analysis, Soil tests, Analytical techniques, Elements (chemical), Root zone, Voids, Iron, Nutrients.

Electron probe microanalysis was used to follow the distribution of phosphorus and associated elements within soil features to establish the composition of the immediate root environment. Various qualitative analytical modes of using the instrument were described involving either specimen traverse or spectrometer scanning with a static beam, line scanning, one-dimensional scanning, area scanning, or successive rast counting. By these means phosphorus was found to occur variously as discrete grains of rare-earth phosphates, in preferential association with iron in iron/manganese concretions, as concentrations within undifferentiated soil matrix and ferrans at void surfaces, and to be associated with calcium in a fresh root and possibly with iron rather than calcium, aluminum, or potassium in an old root.

78:07B-020
ELECTRON PROBE MICROANALYSIS OF CALCITE GRAINS CONTAINING PHOSPHORUS IN SOIL,
Qureshi, R.H., and Jenkins, D.A.
Agricultural University, Lyallpur, Department of Soil Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 703-705, September-October, 1978. 4 fig, 11 ref.
(See 78:02K-045)

78:07B-021
MEASUREMENT OF FURROW INFILTRATION RATES MADE EASY,
Miller, D.E., and Rasmussen, W.W.
Federal Research, Science and Education Administration, Prosser, Washington, United States Department of Agriculture.
Soil Science Society of America Journal, Vol. 42, No. 5, p 838-839, September-October, 1978. 3 fig, 1 tab, 9 ref.

Descriptors: Infiltration rates, Infiltration, Furrow irrigation, Infiltrometers, Computer programs, Measurement.

An irrigation system was developed for infiltration studies that utilized overflow controls to maintain nearly constant inflow into irrigation furrows. Furrow outflow was measured with HS flumes equipped with water-level recorders. Data were easily and rapidly converted to infiltration rates and cumulative infiltration by a computer.

78:07B-022
GRAVIMETRIC VS. VOLUMETRIC DETERMINATION OF WATER STORAGE IN VERTICALLY UNSTABLE TILLAGE LAYERS,
Steinhardt, R.
Institute of Soils and Water, Agricultural Research Organization, The Volcani Center, Bet Dagan, Israel, Division of Soil Physics.
Soil Science Society of America Journal, Vol. 42, No. 5, p 836-837, September-October, 1978. 1 tab, 14 ref, 5 equ.

Descriptors: Water storage, Soil water, Moisture content, Soil compaction, Frost heaving, Drainage, Irrigation, Gravimetric analysis, Volumetric analysis, Methodology.

Methods of determining water storage (W) in a tillage layer of changing height were analyzed to compare the effects of agrotechnical management on W. It was shown that changes in W may be evaluated from a single estimate of the solid mass per unit area at a state of reference and periodic observations of the gravimetric water content of the tillage layer, which is equivalent to the usual procedure of stable soils.

78:07B-023
DIRECT IN-FIELD MEASUREMENT OF NITROUS OXIDE FLUX FROM SOILS,
Ryden, J.C., Lund, L.J., and Focht, D.D.
California University, Riverside, Department of Soil and Environmental Science.
Soil Science Society of America Journal, Vol. 42, No. 5, p 731-737, September-October, 1978. 2 fig, 5 tab, 29 ref.

Descriptors: Denitrification, Nitrates, Gas chromatography, Measurement, Fertilization, Ozone, Methodology, Data collections.

A method was developed whereby nitrous oxide N2O effusing from a soil surface could be contained and selectively trapped for subsequent analysis. The methodology proposed provides a direct measurement of N2O flux which is integrated over the sampling period used. The methodology is sufficiently simple that it embodies a monitoring capability which can be used to measure N2O evolution in on-going agricultural practice. The method may also provide a basis for the direct measurement of total N loss as a result of denitrification, if the further reduction of N2O to N2 can be inhibited.

78:07B-024
FIELD TESTING OF SEVERAL NITROGEN AVAILABILITY INDEXES,
Fox, R.H., and Piekielek, W.P.
Pennsylvania State University, University Park, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 5, p 747-750, September-October, 1978. 2 fig, 3 tab, 9 ref.

Descriptors: Nitrogen, Fertilization, Soil tests, Crop production, Chemical analysis, Crop response, Corn (field), Laboratory tests.

Eight N availability indexes were correlated with the capability of eight Pennsylvania soils to supply N to field-grown corn (Zea mays L.) in 1976 and 1977. Boiling 0.01M CaCl2 and 0.01M NaHCO3-extractable N were both significantly correlated at the 1% level (r = 0.86 and 0.77, respectively) with the N-supplying capability of the soils from the combined 1976 and 1977 experiments. Autoclave-extractable NH4-N and total soil N were significantly correlated with the soil supplying capability at the 5% confidence level (r=0.70 and 0.68, respectively). Walkley-Black soil organic matter, soil NO3(-), and H2SO4-extractable and KCl-extractable N were not significantly correlated with N availability in the field. Though four of the indexes were well correlated with the N availability in the soil, time and expense necessary for these analyses may preclude their being used routinely by soil testing laboratories.

78:07B-025
REMOTE SENSING OF WATER LEVELS IN SMALL DIAMETER WELLS,
Lovell, A.D., Ellis, J.W., Bruce, R.R., and Thomas, A.W.
United States Department of Agriculture, Science and Education Administration, Watkinsville, Georgia 30677.
Agricultural Engineering, Vol. 59, No. 10, p 44-45, October, 1978. 4 fig.

Descriptors: Water level recorders, Water level fluctuations, Water levels, Remote sensing, Pressure head, Piezometers.

A remote sensing device was developed that measures water level changes in potentiometer resistance. This device is capable to follow water levels in small-diameter piezometer tubes installed at depth ranging from 125 cm to 305 cm and can measure the water level to within about 5 mm.

78:07B-026
AUTOMATED SAMPLING ANALYSIS OF RURAL NONPOINT SOURCE WATER QUALITY,
Humenik, F.J., Bliven, L.F., Koehler, F.A., and Overcash, M.R.
North Carolina State University, Raleigh, Department of Biological and Agricultural Engineering.
Paper No. 78-2509, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978. Palmer House Hotel, Chicago, Illinois, 10 p. 5 fig, 4 tab, 18 ref, 2 equ.

Descriptors: Water quality, Water pollution, Water sampling, Water pollution sources, Automation, Water yield, Ion transport, Base flow, Flow duration.

Automated sampling was employed to assess constituent (COD, TOC, TP, TKN, NO3-N, and Cl) yields and concentrations from two Piedmont sites in Virginia and two poorly-drained Coastal Plain sites in North Carolina within the Chowan River watershed. These data were analyzed to provide a mechanistic interpretation of subbasin processes. Characteristic Piedmont and Coastal Plain seasonal water yield cycles which have winter maximums and summer minimums were related to regional potential water yields (rainfall minus evapotranspiration). Large water yield variations for subbasins within each region, however, were attributed by physical differences between subbasins. Greater water yield from the agricultural Piedmont site than from the forested Piedmont site reflected increased cleared land plus greater channelization both on the basis of channel density and channel gradient at the agricultural site. Elevated baseflow, probably due to stream channelization, was the dominant factor contributing to water yield differences between two Coastal Plain subbasins. Surface flow COD, TOC, TP, TKN and NO3-N concentrations were usually greater than baseflow concentrations, but at the unchannelized Coastal Plain site the opposite case prevailed and at all sites surface flow Cl concentrations were less than baseflow concentrations. The seasonal concentration cycle displayed a summer maximum and winter minimum and thus it was out of phase with the water yield cycle.

78:07B-027
MEASURING FLUMES OF SIMPLIFIED CONSTRUCTION,
Replogle, J.A., and Clemmens, A.J.
United States Water Conservation Laboratory, Science and Education Administration, Phoenix, Arizona, Department of Agriculture.
Paper No. 78-2506, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 10 fig, 3 tab, 15 ref.

Descriptors: Flumes, Measurement, Mathematical models, Flow measurement, Irrigation canals, Critical flow, Construction costs.

Mathematical modeling was applied to optimize error control and construction simplicity for the selection of a family of long-throated flumes, resembling broad-crested weirs with a sloping approach ramp, for use in trapezoidal irrigation canals. Alternate shapes and sizes were proposed for unlined canals with extensions to sizes and shapes for limited application to watershed work.

78:07B-028
SAMPLING AND CHEMICAL INTERPRETATION OF PRECIPITATION FOR MASS BALANCE STUDIES,
Lewis, W.M., and Grant, M.C.
Colorado University, Boulder, Department of Environmental Population and Organismic Biology.
Water Resources Research, Vol. 14, No. 6, p 1098-1104, December, 1978. 2 fig, 1 tab, 40 ref.

Descriptors: Precipitation (atmospheric), Chemistry of precipitation, Sampling, Chemical analysis, Rainfall, Rain gages, Design, Data collections.

From an analytical viewpoint, total dry and wet precipitation consists of three fractions: (1) dissolved materials in aqueous precipitation, (2) the water-soluble component of dry precipitation, and (3) the water-insoluble component of either wet or dry precipitation. Methods of precipitation collection and processing greatly affect the separation of these components. A literature survey showed that fraction 3 has typically been ignored and that samplers currently in use lead to a highly variable mixture of the three fractions. A literature survey also showed that most collectors currently in use are of insufficient size to collect samples large enough to support broad-spectrum analysis on a weekly basis. The minimum satisfactory size of collectors was computed from (1) average rain chemistry, (2) sensitivity of standard chemical tests for chemical species of biological interest, and (3) volume required for each analysis. The computations showed that collectors should have an area of at last 1200 sq cm in regions of average chemistry and as much as 8300 sq cm in cold climates with minimal aqueous precipitation. A design was given for a collector which combines large size with other desirable features.

78:07B-029
SERIOUS INTERFERENCES IN THE DETERMINATION OF TRACE METALS IN SOILS BE FLAME AND FLAMELESS ATOMIC ABSORPTION SPECTROMETRY,
Mubarak, A., Hageman, L., Howald, R.A., and Woodriff, R.
Montana College of Mineral Science and Technology, Butte, Department of Chemistry.
Soil Science Society of America Journal, Vol. 42, No. 6, p 889-891, November-December, 1978. 5 tab, 14 ref.
(See 78:02K-059)

78:07B-030
OXYGEN FLUX MEASUREMENT IN UNSATURATED SOILS,
Rankin, J.M., and Sumner, M.E.
Malcomess Ltd., Isando, South Africa, Department of Agronomy.
Soil Science Society of America Journal, Vol. 42, No. 6, p 869-873, November-December, 1978. 3 fig, 3 tab, 12 ref.

Descriptors: Oxygen, Soil gases, Diffusion, Aeration, Deaeration, Oxidation-reduction potential, Electrodes, Measurement, Instrumentation, Electrical resistance.

Because in unsaturated soil systems the plateau of the current-voltage curve is not well developed or is absent, 02 reduction at the platinum microelectrode is not diffusion controlled and consequently measured current depends continuously on applied potential. To overcome this difficulty an 02 flux meter was designed which carefully controls and measures the applied potential and enables the effective potential at the electrode to be measured precisely. The instrument, which has facilities for measuring soil electrical resistance, electrode redox potential, and 02 reduction current was fully described together with a circuit diagram. Because the surface oxide condition of the microelectrode is crucial to reproducible results, electrode pretreatment involving gentle abrasion in wet fine sand is necessary to standardize conditions prior to measurement. The results showed that the instrument is suitable for measuring 02 flux in unsaturated systems, and that measured current was closely related to soil airspace.

78:07B-031
DETERMINATION OF THE APPARENT DISPERSION COEFFICIENT OF SOLUTES IN UNSATURATED SOIL,
Paetzold, R.F., and Scott, H.D.
United States Department of Agriculture, Soil Conservation Service, National Soil Survey Laboratory, Lincoln, Nebraska 68508.
Soil Science Society of America Journal, Vol. 42, No. 6, p 874-877, November-December, 1978. 3 fig, 1 tab, 14 ref, 16 equ.
(See 78:02K-062)

78:07B-032
TO MARK SAMPLING EVENTS ON A RUNOFF HYDROGRAPH,
Johnson, A.T., Kort, R., and Ayars, J.E.
Maryland University, College Park, Department of Agricultural Engineering.
Agricultural Engineering, Vol. 59, No. 9, p 22-23, September, 1978. 2 fig.

Descriptors: Runoff, Hydrographs, Intermittent streams, Instrumentation, Stream gages.

This article described how a Stevens Type F Water Stage Recorder can be modified to make it more practical for runoff studies and to monitor streams where flow is intermittent.

78:07B-033
THE PREDICTION OF MEAN MONTHLY SOIL TEMPERATURE FROM MEAN MONTHLY AIR TEMPERATURE,
Toy, T.J., Kuhaida, A.J., and Munson, B.E.
Denver University, Denver, Colorado, Department of Geography,
Soil Science, Vol. 126, No. 3, p 181-189, September, 1978. 4 fig, 3 tab, 13 ref, 5 equ.

Descriptors: Soil temperature, Air temperature, Climatic data, Estimating equations.

Though soil temperature is important to a variety of earth science subdisciplines, data are collected at few locations. This report presented simple, linear models for estimating mean annual, seasonal, and monthly soil temperatures with reasonable accuracy, using only air temperature data. A general equation based on all months and all sample stations taken together, seasonal equations, and equations for individual stations were provided. These models can be used to estimate soil temperature from air temperature data collected by the National Weather Service at stations throughout the United States.

78:07B-034
SOIL MOISTURE DETERMINATION USING MICROWAVE RADIATION,
Hankin, L., and Sawhney, B.L.
The Connecticut Agricultural Experiment Station, Box 1106, New Haven, Connecticut 06504.
Soil Science, Vol. 126, No. 5, p 313-315, November, 1978. 1 fig, 4 tab, 5 ref.

Descriptors: Moisture content, Soil moisture, Gravimetric analysis, Laboratory tests, Laboratory equipment, Sampling, Microwaves, Moisture.

The advantages of microwave treatment over conventional heating are simplicity of operation and speed, especially in experimental studies where changes in design are necessary as experiment proceeds. A simplified method was reported in this article for soil moisture determination by microwave oven using ordinary filter paper folded into cups for holding the sample. Two soils, a heavy-textured and a light-textured soil; and two fine clays, montmorillonite and kaolinite were used in this study. By the method described in this paper, the optimum heating time was found to be 6 minutes and about a 10 g sample appeared to be most convenient for moisture determination by the method described in this article.

78:07B-035
MODIFICATIONS TO A SOIL OXYGEN DIFFUSION RATEMETER,
Bornstein, J., and McGuirk, M.
Maine University, Orono, Northeast Plant, Soil, and Water Laboratory.
Soil Science, Vol. 126, No. 5, p 280-284, November, 1978. 1 fig, 5 ref, 5 equ.

Descriptors: Aeration, Soil gases, Oxygen, Laboratory equipment, Diffusion, Electrical resistance, Laboratory tests, Calibrations.

Recent efforts to relate soil aeration to crop production rely in part on soil oxygen diffusion rate (ODR) measurements. The platinum microelectrode method is often used to measure the soil ODR. The electrode current is easily interpreted when the soil is saturated with water. When the soil is not saturated, the interpretation of the electrode current depends on the effective potential applied to the microelectrode. The effective potential cannot be measured directly, but is calculated from several other measured quantities. The equation for obtaining the effective potential is given for two types of ODR measurement systems. The second type is commercially available and offers several advantages, but has limited accuracy at low ODRs. Two modifications to the commerical system were described, both of which greatly increase the accuracy of the system.

78:07B-036
IN SITU HYDRAULIC CONDUCTIVITY OF A FRAGIPAN SOIL IN THE SOUTHERN COASTAL PLAINS,
Prasad, K.G., and Perkins, H.F.
Georgia University, Athens.
Soil Science, Vol. 126, No. 5, p 263-268, November, 1978. 3 fig, 2 tab, 21 ref.

Descriptors: Hydraulic conductivity, Hydrologic properties, Soil horizons, Coastal plains, Moisture availability, Soil water, Perched water.

More than 250,000 ha of soils having a fragipan or fragic properties occur in the Southern Coastal Plains Soil Province. These soils have moderate to severe land use restrictions, partially due to perched water, slow permeability, and restricted root growth. The Cowarts soil (Fragic Paleudults; fine-loamy, siliceous, thermic family), which is developed from marine sediments, was selected to determine in situ hydraulic conductivities and related hydrological properties. The moderately well-expressed fragipan has higher bulk density, less pore space, smaller pores, less available water, and lower hydraulic conductivity values than horizons above or below the pan. With an increase in hydraulic head, an increase in hydraulic conductivity was less in the fragipan than in associated horizons.

SECTION XXXIII

RESOURCES DATA

EVALUATION, PROCESSING AND PUBLICATION (GROUP 07C)

78:07C-001
ESTIMATION OF AGRICULTURAL NONPOINT LOADS TO THE WAKARUSA RIVER BASIN USING THE "NONPOINT CALCULATOR",
Davis, M.J., and Nebgen, J.W.
Midwest Research Institute, Kansas City, Missouri.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference, p 525-550. 1 fig, 14 tab, 2 ref, 7 equ.
(See 78:05G-063)

SECTION XXXIV

ENGINEERING WORKS

STRUCTURES (GROUP 08A)

78:08A-001
IRRIGATION PIPE REPAIR CUTS COSTS,
Larsen, R., Associate Editor.
Irrigation Age Magazine.
Irrigation Age, Vol. 12, No. 7, p 6, April, 1978. 1 fig.

Descriptors: Pipelines, Pipes, Repairing, Cost comparisons, Colorado, Equipment, Instrumentation, Maintenance, Engineering structures.

The experience of a Colorado farmer who designed a repair operation for damaged aluminum irrigation pipes was discussed. Repairing damaged pipes has proved to be considerably cost-effective in comparison to the costs for new pipes.

78:08A-002
TRENCHLESS DRAINAGE,
Reeve, R.C.
Advanced Drainage Systems, Incorporated, Columbus, Ohio.
Paper No. 78-2042, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 9 p. 9 fig.

Descriptors: Subsurface drainage, Subsurface drains, Drainage practices, Trenches, Maintenance costs, Installation, Groundwater, Drainage.

Following the development of corrugated plastic tubing and automatic laser grade control in the 1960s, a dramatic move to "trenchless" drainage has taken place in the 1970s. Low maintenance costs and high installation rates (up to 50,000 ft per day) has given the competitive edge that is shifting the industry from trench to "trenchless" drainage.

78:08A-003
SEDIMENT TRAPS IN CHANNELS--DESIGN PROCEDURES AND PERFORMANCE,
Konwinski, G.R.
Soil Conservation Service, East Lansing, Michigan.
Paper No. 78-2561, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 6 p. 2 fig.
(See 78:02J-028)

78:08A-004
DEVELOPMENT AND APPLICATION OF SEDIMENT BASINS IN MARYLAND,
Boysen, S.M.
Soil Conservation Service, College Park, Maryland, United States Department of Agriculture.
Paper No. 78-2562, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 2 fig, 9 ref, 1 append.

Descriptors: Sediment control, Trap efficiency, Soil erosion, Design criteria, Design standards, Specifications, Sediment yield, Detention reservoirs, Skimming.

Sediment basins are an important part of the sediment control program in Maryland. Criteria were presented for estimating trap efficiency of basins. Experiences and results of field observations were presented. Standards and specifications prepared by the Soil Conservation Service for sediment basins in Maryland were attached.

SECTION XXXV

ENGINEERING WORKS

HYDRAULICS (GROUP 08B)

78:08B-001
APPLICABILITY OF KINEMATIC AND DIFFUSION MODELS,
Ponce, V.M., Li, R.M., and Simons, D.B.
Colorado State University, Fort Collins, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY3, Proceedings Paper 13635, p 353-360, March, 1978. 4 fig, 1 tab, 5 ref, 3 append.

Descriptors: *Diffusion, *Model studies, *Open channels, *Kinematic models, Dynamics, River beds, Waves (water), Saint Venant equation, Wave period, Mathematical studies.

The applicability of the kinematic and diffusion models of open channel flow was assessed by comparing the propagation characteristics of sinusoidal perturbations to the steady uniform flow for the kinematic, diffusion, and dynamic models (the dynamic model is that based on the complete Saint Venant equations). The comparison allowed the determination of inequality criteria that need to be satisfied if the kinematic or diffusion models are to simulate the physical phenomena within a prescribed accuracy. It was shown that bed slope and wave period (akin to wave duration in waves of shape other than sinusoidal) are the important physical characteristics in determining the applicability of the approximate models. Larger bed slopes or long wave periods, or both, will satisfy the inequality criteria. In practice, larger bed slopes are those of overland flow, and long wave periods are those corresponding to slow-rising flood waves.

78:08B-002
DIRECT SOLUTION TO PROBLEMS OF OPEN CHANNEL TRANSITIONS,
Vittal, N.
Roorkee University, India, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY11, p 1485-1494, November, 1978. 6 fig, 1 ref, 17 equ, 2 append.

Descriptors: Transition flow, Open channel flow, Subcritical flow, Critical flow, Open channels, Hydraulic design, Culverts, Aqueducts, Graphical methods, Flow characteristics.

The existing methods of solving open channel transitions involve trial-and-error solution of higher degree equations. In this paper, a method was proposed which presents unique dimensionless discharge-depth relationships for exponential, trapezoidal, and circular channels that facilitate direct solutions even to complex problems of contracting open channel transitions. The steps enumerated in the examples demonstrated the simplicity of the method. It was recommended that enlarged design charts of the proposed graphical relations are used in actual design for accuracy. Alternatively, design tables prepared from given equations may also be used.

78:08B-003
HYDRODYNAMIC PERFORMANCE OF PIPE UNDERDRAINS,
Mevorach, J., and Zanker, K.
Technion-Israel Institute of Technology, Haifa, Department of Hydrodynamics and Hydraulic Engineering.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, Proceedings Paper 13636, p 127-142, March, 1978. 15 fig, 4 ref, 2 append.

Descriptors: *Valves, *Hydraulic valves, *Drainage, Channels, Flow, Drains, Pipes, Sediments, Groundwater, Flexible-flap drain valves.

Theoretical analysis and laboratory investigations of flexible-flap drain valve in high-velocity open channel flow were presented. Main hydrodynamic characteristics of the valve are: (1) Radial diffuser action, which prevents the valve from opening at low pressures; and (2) uplift forces, caused by high-velocity flow in the channel, helping the valve to open. The most severe condition for the valve operation is when there is little or no flow in the channel, but there is still high groundwater table around the channel. Flap-valves are found suitable for use in high-velocity flows, provided that the ratio, R sub 2/R sub 1, between the circular flap and the valve opening is kept as low as compatible with engineering considerations.

78:08B-004
SIMULATED FLOW RATE REQUIREMENTS FOR SOME FLUSHING EMITTERS,
Solomon, K., and Bezdek, J.C.
Utah State University, Logan, Department of Mathematics.
Paper No. 78-2016, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p. 3 fig, 5 tab, 8 ref, 1 equ.

Descriptors: Flow rates, Simulation analysis, Hydraulic models, Irrigation, Lateral conveyance structures, Model studies, Irrigation systems, Hydraulic properties, Water pressure.

A steady state simulation model was used to study the hydraulic behavior of trickle irrigation laterals and manifolds employing automatic flushing emitters. The influence of emitter characteristics and design values such as emitter operating pressure, flow rate, spacing, and lateral length were considered.

78:08B-005
TRICKLE IRRIGATION TUBING HYDRAULICS,
Watters, G.Z., and Keller, J.
Utah State University, Logan, Department of Civil and Environmental Engineering.
Paper No. 78-2015, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 18 p. 16 fig, 2 tab, 12 ref, 14 equ.

Descriptors: Pipe flow, Hydraulic properties, Irrigation systems, Head loss, Darcy-Weisbach equation, Moody resistance diagrams, Pipelines, Hazen-Williams equation, Analytical techniques, Graphical methods.

Laboratory experiments show that the Darcy-Weisbach equation for hydraulically smooth pipes should be used to compute friction losses in PVC pipe and plastic tubing. Simple formulas are presented to accomplish this. Graphs to find equivalent lengths for emitter connection losses are given. Techniques for calculating head losses in multiple-outlet lines are presented.

78:08B-006
PRESSURE LOSSES ACROSS TRICKLE IRRIGATION FITTINGS AND EMITTERS,
Howell, T.A., and Barinas, F.A.
Texas A & M University, College Station, Department of Agricultural Engineering.
Paper No. 78-2014, Presented at the 1978 Summer Meeting of the American Society of Agricultural Engineers, June 27-30, 1978, Logan, Utah, 12 p. 16 fig, 1 tab, 7 ref, 10 equ.

Descriptors: Energy loss, Energy gradient, Irrigation design, Flow rates, Lateral conveyance structures, Pipelines, Pressure conduits, Irrigation systems, Water pressure, Hazen-Williams equation.

Pressure losses across on-line trickle emitters were measured. The energy losses as expressed by the equivalent length of pipe were described by a power function. The empirical coefficients were related to the emitter characteristics of protrusion depth and area. Lateral design procedures and examples are presented. Pressure losses across PVC and PE barbed fittings were measured.

78:08B-007
SIZE DETERMINATION OF PARTLY FULL CONDUITS,
Mussalli, Y.G.
Stone and Webster Engineering Corporation, Boston, MA. Hydraulic Division.
Journal of Hydraulic Division, American Society of Civil Engineers, Vol. 104,
No. HY7, Proceedings Paper 13862, p 959-974, July, 1978. 13 fig, 2 tab, 9 ref.

Descriptors: *Air-water interfaces, *Flow control, *Free surfaces, *Air-water interactions, Surface runoff, Vibrations, Hydraulics, Mathematical studies, Equations, Water tunnels.

The transition from partly full to full pipe (sealing) is accompanied by vibrations of the structure and surging of the flow. The experimental study was done in a 4-in (100-mm) square conduit with three different circular bends, with various deflectors, and with various concentrations of air. Sealing depends on the Froude number of the flow. To maintain partly full flow, more space is needed above the water-flow area with an increase of Froude number. With short-tube control, the ratio of the radius of curvature along the center line to the bend diameter and the deflector thickness at the crown of the bend determine the water-flow area in the horizontal conduit. Ventilation of the horizontal conduit delays sealing, while aeration of the water flow hastens sealing. With weir control, waves on the flow surface hasten sealing, and highly acrated flow delays sealing. Ratios of radius of curvature to the bend diameter larger than 2.0 were recommended since they generate fewer waves.

78:08B-008
VARIED FLOW FUNCTIONS FOR CIRCULAR CHANNELS,
Nalluri, C., and Tomlinson, J.H.
Newcastle-upon-Tyne., England, Department of Civil Engineering.
Journal of Hydraulics Division, American Society of Civil Engineers, Vol. 104,
No. HY7, Proceedings Paper 13889, p 983-1000, July, 1978. 2 fig, 4 tab, 11 ref.

Descriptors: *Backwater, *Channels, *Flow, Conduits, Flow profiles, Gradually varied flow, Open channels, Pipes, Hydraulics, Backwater profiles.

Hydraulic engineers often are required to compute backwater curves, and the existing methods cannot be applied accurately to closed conduits as the flow approaches the crown. This paper reviewed the Keifer and Chu method which uses the dimensionless parameter Q/QCAP. A new approach was developed to compute backwater curves in circular channels in which the factor Q/QCAP is removed so that errors are not introduced by having to interpolate these values. This new method is applicable for all possible bed slope conditions (horizontal, adverse), which is a distinct advantage over the other existing techniques. Semigraphical methods also were suggested to increase the speed of computation of backwater curves.

78:08B-009
AMERICAN DEVELOPMENTS IN HYDRAULIC MEASUREMENT,
Ripken, J.F.
Minnesota University, Minneapolis, St. Anthony Falls Hydraulic Laboratory.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104,
No. HY6, Proceedings Paper 13821, p 857-868, June, 1978. 1 ref, 1 append.

Descriptors: *Measurement, *Instrumentation, *Discharge (water), *Flow measurement, *History, Wiers, Electronic equipment, Orifices, Hydrometry, Flumes.

A historical summary is presented of American contributions to hydraulic measurement of streamflow for the period 1776-1976. The development and interrelation of conduit flow measuring devices, together with open channel measuring devices, was included in this update of previous historical summaries. The narrative style and historical sequencing is a useful complement to the more specific "Bibliography on Discharge Measurement Techniques."

78:08B-010
HYDRAULIC FRICTION LOSS IN SMALL DIAMETER PLASTIC PIPELINES,
Hughes, T.C., and Jeppson, R.W.
Utah State University, Logan, Department of Civil and Environmental Engineering.

Water Resources Bulletin, Vol. 14, No. 5, p 1159-1166, October, 1978. 1 fig, 1 tab, 2 ref, 4 equ, 1 append.

Descriptors: Plastic pipe, Hydraulic conduits, Pipe flow, Design, Hazen-Williams equation, Darcy-Weisbach equation, Reynolds number, Flow friction, Water supply, Moody resistance diagrams.

Field measured friction losses in three one-mile sections of small diameter pvc pipe which have been in service for ten years is reported. Hazen-Williams and Darcy-Weisbach equations were examined to provide a framework for comparing Hazen-Williams coefficients recommended by pipe manufacturers to those obtained by the field measurements. It was concluded that the Hazen-Williams coefficient of 150 recommended by most pvc pipe manufacturers is too high for the diameter-velocity combinations encountered in rural dead-end small diameter lines. The measured coefficients averaged 133 which is close to that predicted by superimposing Hazen-Williams coefficients on the Moody diagram from which the friction factor for the Darcy-Weisbach equation is obtained.

78:08B-011
KALMAN FILTER IN OPEN CHANNEL FLOW ESTIMATION,
Chiu, C.L., and Isu, E.O.
Pittsburgh University, Pennsylvania, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY8, Proceedings Paper 13946, p 1137-1152, August, 1978. 9 fig, 19 ref.

Descriptors: *Open channels, *Model studies, *Open channel flow, *Kalman filter, Mannings equation, Estimating, Resistence coefficients, Manning formula, Open channel hydraulics, Hydraulics.

In computing water surface profiles in open channels, uncertainties often arise in selection of resistance coefficients, such as Manning's n. In this paper the Kalman filtering approach was developed to deal with such uncertainties. This approach combined a mathematical system model and an observation model. The former consists of (1) stochastic nonlinear differential equation governing the steady one-dimensional open channel flow; and (2) one of three possible stochastic differential equations expressing Manning's n (constant, function of the location of channel cross section, or function of both the location and the water depth). The observation model simply shows the observed water depth as the sum of "true water depth" and "error". The estimation technique was tested for its accuracy in generating estimates of water depth and Manning's n at several different schemes of sampling or measuring water depths. Results with Kalman filtering were compared with two parallel methods normally used today.

78:08B-012
AIR-WATER FLOW IN COARSE GRANULAR MEDIA,
Hannoura, A.A., and McCorquodale, J.A.
Windsor University, Ontario, Department of Civil Engineering.
Journal of the Hydraulic Division, American Society of Civil Engineers, Vol. 104, No. HY7, Proceedings Paper 13888, p 1001-1010, July, 1978. 5 fig, 1 tab, 15 ref.

Descriptors: *Breakwaters, *Darcys law, *Granules, *Porous media, *Coastal engineering, Entrainment, Hydraulic conductivity, Waves (water), Hydraulics, Air-water interfaces.

Air may be entrained in the flow in porous shore structure under wave action. Three conceptual models for two-phase flow in ducts were adapted to describe flow in coarse granular media. These are the homogeneous bubbly drift-flux, and slug drift-flux models. An experimental study was undertaken to check the three models against air-water flow in three coarse granular porous media. The best model was chosen based on its agreement with the experimental head drop results. On this basis, the slug flow drift-flux model was recommended to calculate the effect of entrained air on the hydraulic conductivity for co-current and counter current flows.

78:08B-013
DISPERSION IN RIVERS AS RELATED TO STORAGE ZONES,
Sabol, G.V., and Nordin, C.F.
New Mexico State University, University Park, Department of Civil Engineering.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY5, Proceedings Paper 13758, p 695-708, May, 1978. 4 fig, 3 tab, 26 ref, 2 append.

Descriptors: *Dispersion, *Rivers, *Reservoirs, *Model studies, Mathematical models, Suspended solids, Markov processes, Theoretical analysis, Sedimentation, River flow.

Longitudinal dispersion was considered as a simple stochastic process in which a particle travels random time periods at constant velocity, with travel period separated by random time periods during which the particle is trapped in storage zones. The average number per unit time of entries into storage was considered to be a function of time. The resulting model was a nonhomogeneous compound Poisson process defined by three parameters. Methods for estimating the parameters were given, and predicted concentration distributions were shown to agree reasonably well with observed field data.

SECTION XXXVI

ENGINEERING WORKS

HYDRAULIC MACHINERY (GROUP 08C)

78:08C-001
COLORADO PUMP TESTS SHOW HOW TO MAKE BIG DOLLAR SAVINGS,
Ross, R.
Irrigation Age, Vol. 12, No. 6, p 8-9+, March, 1978. 2 fig.

Descriptors: *Irrigation operation and maintenance, *Pumping, Energy, Costs, Efficiencies, Electric power costs, Electric power rates, Conservation.

A recent pump testing program in Colorado has demonstrated a huge potential for electrical energy savings in that state if the average efficiency of irrigation pumps could be upgraded. Program researchers have maintained that efficiencies of 65% are readily achievable by proper pump selection and care, and significant number of systems tested were found to perform at this level. However, average efficiencies in approximately 600 systems tested were only about 45% for open discharge systems and 56-60% for sprinklers. Various remedial measures can be taken to improve pump efficiency, such as adjustment of the impeller, replacement of worn parts, proper sizing, improved well construction, and modification of operating procedures. Unfortunately, present electrical rate structures frequently discourage such measures. Net savings in a declining block rate structure, for example, may be to low to offset the capital cost of upgrading the irrigation system, thus the farmer's decision is not to repair the pump. If irrigation power rates were reformulated so that cost to the farmer were closer to the actual average cost per kwh, then the economic incentive to conserve energy would be enhanced.

SECTION XXXVII

ENGINEERING WORKS

ROCK MECHANICS AND GEOLOGY (GROUP 08E)

78:08E-001
DESIGN UNDER STOCHASTIC GROUNDWATER FLUCTUATION,
Bogardi, I., and Duckstein, L.
Arizona University, Tucson, Department of Hydrology and Water Resources.
Journal of the Hydraulics Division, American Society of Civil Engineers, Vol. 104, No. HY1, Proceedings Paper 13499, p 59-74, January, 1978. 4 fig, 3 tab, 22 ref, 4 append.

Descriptors: *Aquifers, *Groundwater, *Concrete structures, *Stochastic processes, *Failure (mechanics), *Hungary, *Danube River, *Budapest (Hungary), Bivariate analysis, Decision theory.

A foundation is to be protected against the harmful effects of sulfur groundwater, whose piezometric head fluctuates in a random manner. The stochastic process forms a partial duration series, where the jth event is defined by the maximum exceedance above the foundation floor, the duration and interarrival time until the (j + 1)st event. To protect the structure against possible damage by high levels of groundwater with substantial sulfate concentration, it is possible to make four decisions, corresponding to waterproofing or using special sulfate resistant concrete or both, or providing no protection. The annual cost and expected loss associated with each of these four decisions were calculated with the help of explicit expressions. Sensitivity of the decision to sample, model, and economic uncertainty was analyzed as well as the possibility of using a Bayesian approach to account for sample uncertainty.

SECTION XXXVIII

ENGINEERING WORKS

MATERIALS (GROUP 08G)

78:08G-001
ASPHALT-CRUMB RUBBER WATERPROOFING MEMBRANE,
Frobel, R.K., Jimenez, R.A., Cluff, C.B., and Morris, G.R.
Arizona University, Tucson, Water Resources Research Center.
Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 104, No. IR1, p 43-58, March, 1978. 10 fig, 1 tab, 11 ref, 4 equ, 1 append.

Descriptors: Linings, Reservoir leakage, Seepage, Seepage control, Waterproofing, Asphaltic concrete, Laboratory tests.

A mixture of asphalt cement mixed with crumb-rubber (asphalt-rubber) has been used successfully in highway construction for several years in Arizona and other states. This paper describes laboratory tests on asphalt-rubber and includes preliminary results of an actual reservoir lining application.

78:08G-002
PREDICTION OF DEFLECTION FOR CORRUGATED PLASTIC TUBING,
Fenemor, A.D., Bevier, B.R., and Schwab, G.O.
Ohio Agricultural Research and Development Center, Columbus, Department of Agricultural Engineering.
Paper No. 78-2542, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 4 fig, 3 tab, 13 ref, 12 equ.

Descriptors: Subsurface drains, Plastic pipes, Failure (mechanics), Deflection, Pipes, Tubes, Drainage, Subsurface drainage, Installation, Soil tests.

Measured deflections of tubing buried five years ago in a silty clay showed that the soil provides practically no side support against deflection. With measured deflection lag factors, the Iowa formula was the best of four methods for predicting deflection. Recommended maximum depths of burial are tabulated for tubing up to 381 mm diameter.

78:08G-003
FAILURE CRITERIA FOR CORRUGATED-PLASTIC DRAIN TUBING,
Walker, P.N., Armstrong, C.L., and Singh, P.N.
Illinois University, Urbana, Department of Agricultural Engineering.
Paper No. 78-2439, Presented at the 1978 Winter Meeting of the American Society of Agricultural Engineers, December 18-20, 1978, Palmer House Hotel, Chicago, Illinois, 13 p. 8 fig, 2 tab, 5 ref, 8 equ.

Descriptors: Plastic pipes, Subsurface drains, Failure (mechanics), Tubes, Drainage, Subsurface drainage, Pipes, Deflection, Installation.

Results from hydraulic-capacity, pipe-stiffness, and live-load carrying-capacity tests of permanently deflected drain tubing are presented. These tests are part of a continuing effort to define failure criteria for plastic drain tubing.

SECTION XXXIX

MANPOWER, GRANTS, AND FACILITIES

EDUCATION - EXTRAMURAL (GROUP 09A)

78:09A-001
ASCE MET SECTION STRIVING TO MAKE CIVIL ENGINEERING CURRICULA MORE PRACTICE-ORIENTED,
Khera, R.P.
New Jersey Institute of Technology, Newark, Department of Civil Engineering.
Civil Engineering, Vol. 48, No. 1, p 75, January, 1978.

Descriptors: Civil engineering, Engineering education, Education, Engineering, Evaluation.

Concerned with deficiencies in civil engineering education and the limitations of the ECPD evaluation procedures, the ASCE Metropolitan Section Committee on Engineering Education set out to upgrade and monitor civil engineering education. A poll of Met Section members showed a desire for change in the direction of civil engineering education. Experimental review program of undergraduate civil engineering education was approved by the Met Section Board in April, 1968. It contemplated periodic visits to each of the undergraduate civil engineering departments in the Metropolitan area by a team of ASCE members. This article discusses in brief about the activities of the ASCE Met Section, the purpose it has served, and the procedure it follows to attain its objectives.

SECTION XL

SCIENTIFIC AND TECHNICAL INFORMATION

ACQUISITION AND PROCESSING (GROUP 10A)

78:10A-001
NATIONAL CONFERENCE ON MANAGEMENT OF NITROGEN IN IRRIGATED AGRICULTURE,
Pratt, P.F., Editor.
Sponsored by U.S. National Science Foundation, U.S. Environmental Protection Agency, University of California.
Proceedings of National Conference on Management of Nitrogen in Irrigated Agriculture, California University, Sacramento, California, p 1-442, May 15-18, 1978. 49 fig, 59 tab, 371 ref, 26 equ.

Descriptors: Nitrogen, Nitrogen cycle, Nitrates, Irrigated land, Water quality, Water management (applied), Conferences.

These Proceedings represent a National Conference on Nitrogen Management in Irrigated Lands, designed to bring together users representing a diversity of interests throughout the country for an integrated review of the findings from the comprehensive national research effort. The accumulated information needs to be utilized as fully as possible by the many individuals and organizations making decisions in current water quality planning. This will help ensure the emergence of appropriate and viable solutions to our water quality problems -- solutions that are sensitive to both local and national needs and priorities.

SECTION XLI

SCIENTIFIC AND TECHNICAL INFORMATION

SECONDARY PUBLICATION AND DISTRIBUTION (GROUP 10C)

78:10C-001
SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS 1976,
Skogerboe, G.V., Smith, S.W., and Walker, W.R.
Colorado State University, Fort Collins, Colorado, Department of Agricultural
and Chemical Engineering.
Publication No. EPA-600/2-78-042, March, 1978. 311 p.

Descriptors: Fertilizers, Irrigated land, Salinity, Return flow.

Research related to the quality of irrigation return flow is being conducted at numerous institutions throughout the western United States. Related work is also underway at other institutions in the United States, as well as other portions of the world. Approximately 100 sources of material have been searched for articles pertinent to the National Irrigation Return Flow Research and Development Program. These articles describe water quality problems resulting from irrigated agriculture, potential technological solutions for controlling return flows, recent research pertinent to return flow investigations, and literature associated with institutional constraints in irrigation return flow quality control. The first annual issue SELECTED IRRIGATION RETURN FLOW QUALITY ABSTRACTS covered publications printed in 1968 and 1969, while the second annual issue lists publications printed in 1970 and 1971, the third annual issue covers literature published in 1974 and 1975. This annual issue lists publications printed in 1976. This report was submitted in fulfillment of Grant Number R-800426 under the sponsorship of the Office of Research and Development, Environmental Protection Agency.

78:10C-002
GROUNDWATER POLLUTION. PART 2. POLLUTION FROM IRRIGATION AND FERTILIZATION.
VOL. 2. 1977-JANUARY, 1978. (CITATIONS FROM THE NTIS DATA BASE),
Brown, R.J., Editor.
National Technical Information Service, 5285 Port Royal Road, Springfield,
Virginia 22161.
NTIS/PS-78-0141, February, 1978. 65 p.

Descriptors: Abstracts, Bibliographies, Groundwater, Water pollution, Irrigation, Fertilization, Water pollution control, Return flow, Research and development, Groundwater recharge.

The bibliography contains abstracts of Federally-funded research covering aspects of groundwater pollution from irrigation and fertilization. The reports include topics dealing with the pollution from sewage and waste water irrigation, land spreading of sludges and solid wastes, nitrate and phosphate accumulation in soils, pollution control and abatement planning, salt build-up from irrigation, the use of tile drains in groundwater pollution control, and groundwater recharge studies.

78:10C-003
THE PESTICIDE CONTENT OF SURFACE WATER DRAINING FROM AGRICULTURAL FIELDS--A REVIEW,
Wauchope, R.D.
Southern Weed Science Laboratory, Science and Education Adminstration, Federal
Research, United States Department of Agriculture, Stoneville, Mississippi 38776.
Journal of Environmental Quality, Vol. 7, No. 4, p 459-472, October-December, 1978.
3 fig, 4 tab, 69 ref.

Descriptors: Agricultural runoff, Surface runoff, Runoff, Pesticides, Water quality, Water pollution, Herbicides, Insecticides, Reviews.

The literature on pesticide losses in runoff waters from agricultural fields was reviewed. For the majority of commercial pesticides, total losses were found to be 0.5% or less of the amounts applied, unless severe rainfall conditions occur within 1-2 weeks after application. Exceptions were noted for the organochlorine insecticides, which might lose about 1% regardless of weather pattern because of their long persistence; and soil surface-applied, wettable-powder formulations of herbicides, which might lose up to 5%, depending on weather and slope, because of the ease of washoff of the powder. The effects of erosion control practices on losses of various types of pesticides were documented. The behavior and fate of pesticides in streams receiving runoff was not clearly determined from the literature. It was concluded that information on such factors as time and distance of impact of a given runoff event, ability of local ecosystems to recover from transient pesticide concentrations, and dissipation or concentration processes in aquatic ecosystems will have to be obtained before "edge-of-field" pesticide losses can be related to water quality in receiving waters.

78:10C-005
CHOICES IN IRRIGATION MANAGEMENT,
British National Committee.
International Commission on Irrigation and Drainage.
ICID Bulletin, Vol. 27, No. 2, p 62-64, July, 1978.

Descriptors: Water management (applied), Irrigation, Groundwater, Irrigation programs, Pricing, Agriculture, Crop production, Water demand, Project post-evaluation.

A "workshop" on choices in irrigation management was organized by the Agricultural Administration Unit of the Overseas Development Institute and held at the University of Kent, Canterbury. The workshop was attended by 35 participants, of whom 12 came from eight different countries in Asia, Africa and Latin America. The majority of these had extensive first-hand experience of irrigation management at project level. Twenty-one papers were presented and discussed. This paper is a summary of these 21 papers discussed under several categories of irrigation management.

78:10C-006
ANNOTATED BIBLIOGRAPHY FOR WATER QUALITY MANAGEMENT, FIFTH EDITION,
Hurd, M.
Water Quality Management Information Center, Program Management Branch, Water Planning Division (WH/554), Washington, D.C. 20460.
EPA Report, Division of Water Planning, Washington, D.C., April, 1978. 64 p.

Descriptors: Bibliographies, Abstracts, Water quality, Water quality act, Water quality control, Return flow, Water pollution, Water management (applied), Waste water (pollution), Waste water treatment.

This bibliography was prepared by U.S. Environmental Protection Agency to assist those agencies engaged in water quality management planning. The references cited have been selected for their applicability to 208 planning and for their availability. Each reference is followed by a short abstract, and whenever possible, by detailed price and ordering information.

78:10C-007
BEST MANAGEMENT PRACTICES FOR AGRICULTURE AND SILVICULTURE,
Loehr, R.C., Haith, D.A., Walter, M.F., and Martin, C.S., Editors.
Cornell University, Ithaca, New York, College of Agriculture and Life Sciences.
Proceedings of the 1978 Cornell Agricultural Waste Management Conference. 154 fig, 159 tab, 490 ref, 57 equ.
(See 78:05G-071)

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